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GENERAL DYNAMICS
Convair Division



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PHASE I FINAL REPORT
SIMULATION
OF SELECTED DISCRETE NETWORKS
VOLUME TWO
USER REFERENCE GUIDE
DISCRETE NETWORK SIMULATION
PROGRAMS

CONTRACT NAS8-20016

Report No. GD/C DDF 65-005

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Prepared by

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September 1965

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INTRODUCTION

The Discrete Network Simulation (DNS) system is based on simulation and analysis techniques developed for the Atlas Weapon System under government and corporate sponsorship. The total technique as applied to the Atlas Weapon System was called FASTI, Fast Access to System Technical Information. This study uses the Discrete Network Simulation portion with a modified version of the documentation and retrieval process. Digital computer programs are used to simulate discrete networks in less than real time. These programs were developed by GD/A and then incorporated into the FASTI system.

The prime purpose of Discrete Network Simulation methodology is to provide a set of analytical tools capable of conducting thorough, accurate and rapid analysis of complex systems. The methodology consists basically of:

- A system network model.

- A set of computer programs which will operate and activate the model.

These programs provide a realistic analysis and prediction of system performance before or after the hardware system is constructed. It is another form of testing; the results are as valid as those obtained by the more common hardware test procedures.

The Discrete Network Simulator (DNS) chronologically simulates events occurring due to the interactions among elements in a system network. Each "event," a Boolean change of state, is the result of a logical cause and effect relationship among elements in the system. The system modeled for the simulation may be a switching circuit, man/machine interaction, or any network where the component or subcomponent interrelations may be defined logically.

Convair is conducting a study under NASA Contract NAS8-20016, which applies the Discrete Network Simulation techniques to the Saturn S1C Engine Cutoff System networks. This report summarizes the results of Phase I and consists of three (3) volumes.

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Volume One describes the methodology for constructing a DNS model.

Volume Two describes the DNS computer programs to the "Programmer." It is the "Users Reference Manual" for DNS.

Volume Three summarizes the study of the SIC Engine Cutoff System. The DNS Model and examples of the system simulation are described.

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THE PROBLEM

PROVIDE A MEANS OF SIMULATING THE BEHAVIOR OF ELECTRICAL SWITCHING CIRCUITS IN TIME AS A FUNCTION OF COMPONENT CHANGE OF STATE ON A GO-NOGO BASIS. WITHIN THE SIMULATION PROCEDURE PROVISION IS TO BE MADE FOR THE INSERTION OF MALFUNCTIONS IN ORDER TO DETERMINE THE EFFECT OF THE MALFUNCTION ON THE SYSTEM OR NETWORK BEING SIMULATED. TIMING IS TO BE ASYNCHRONOUS.

EXPANSION OF THE PROBLEM STATEMENT ADDS THE REQUIREMENT THAT THE COMPUTER PROCEDURES BE ABLE TO HANDLE MORE GENERALIZED SITUATIONS, SPECIFICALLY TO BE ABLE TO SIMULATE ANY SYSTEM SUSCEPTIBLE TO CAUSE-EFFECT SYSTEMS ANALYSIS AND DESCRIBABLE AS A DEPENDENCY NETWORK OR GRAPH.

THE SOLUTION

D I S C R E T E N E T W O R K S Y S T E M S I M U L A T I O N

DISCRETE NETWORK SYSTEM SIMULATION (OR DNS) IS A METHOD OF SIMULATING THE FUNCTIONAL BEHAVIOR (IN GO-NOGO TERMS) OF A SET OF INTERCONNECTED ELEMENTS OR COMPONENTS IN A NETWORK, WHICH IS DESCRIBED BY LOGIC EQUATIONS AND TIME PARAMETERS ASSOCIATED WITH EACH ELEMENT.

THE NETWORK OR SYSTEM IS DESCRIBED BY LOGIC EQUATIONS WHOSE PRINCIPAL OPERATORS ARE THE BOOLEAN OPERATIONS OF AND REPRESENTED BY *, OR REPRESENTED BY +, NOT REPRESENTED BY /, THE ELEMENTS OF WHICH ARE VARIABLES WHOSE VALUE REPRESENTS ITS CURRENT STATE. MODEL BEHAVIOR IS THEN DEFINED AS A SERIES OF STATE CHANGES. THESE CHANGES ARE EFFECTS RESULTING FROM A PREVIOUS CHANGE OF STATE.

IN ADDITION TO THE LOGIC EQUATIONS, DEFINING THE CAUSE-EFFECT RELATIONS OF THE SYSTEM, A SET OF REACTION TIMES FOR EACH VARIABLE ARE REQUIRED. THE RESPONSE TIMES ARE ESSENTIALLY THE TIME REQUIRED FOR A VARIABLE TO GO FROM A QUIET STATE TO AN ACTIVE STATE-CALLED PICK UP TIME, OR TO GO FROM AN ACTIVE STATE TO A QUIET STATE-CALLED DROP OUT TIME.

THE LOGIC EQUATIONS AND THE RESPONSE TIMES CONSTITUTE THE MODEL WHICH IS LOADED INTO A DIGITAL COMPUTER ALONG WITH THE SIMULATION PROGRAM. INPUTS TO THE DNS SIMULATION PROGRAM SIMULATE STARTING ACTIONS, SUCH AS THE FLIPPING OF A LIGHT SWITCH TO TURN ON THE LIGHTS. THESE INPUTS, OFTEN CALLED ACTIVITY INPUTS, ARE THE FORCING FUNCTIONS CAUSING MODEL CAUSE-EFFECT EVALUATION TO TAKE PLACE. EACH ACTION AND REACTION IS PRINTED OUT AS IT OCCURS IN ITS PROPER PLACE IN TIME. THIS PRINT OUT IS CALLED THE SIMULATION HISTORY. SINCE EACH ELEMENT HAS A STATE, IT IS USEFUL TO SEE THE STATES OF ALL THE VARIABLES EITHER AT SPECIFIED TIMES IN THE HISTORY OR AT THAT POINT WHEN THERE IS NO FURTHER ACTION. WHEN EITHER OF THESE OPTIONS ARE REQUESTED THE PROGRAM PRINTS OUT A LIST OF ALL VARIABLE NAMES AND THEIR CORRESPONDING STATES.

SOLUTION IMPLEMENTATION

THE BASIC VEHICLES IMPLEMENTING DNS SIMULATION ARE TWO DIGITAL COMPUTER PROGRAMS WRITTEN FOR AN IBM 7090 DIGITAL COMPUTER. (THESE PROGRAMS WILL ALSO RUN ON AN IBM 7094 AND THE IBM DCS (7044-7094)). THE FIRST PROGRAM PROCESSES AND CONVERTS A DESCRIPTION OF THE SYSTEM MODEL INTO A COMPUTER ASSIMILABLE FORM. THIS IS PRIMARILY A MATTER OF PRACTICALITY WHICH ALLOWS THE BEHAVIOR OF THE MODEL TO BE SIMULATED MANY TIMES WHILE GOING THROUGH THE MODEL CONVERSION PROCESS ONLY ONCE. THE SECOND PROGRAM IS THE SIMULATION PROGRAM WHICH LOADS THE CONVERTED MODEL INTO MEMORY, READS THE ACTIVITY INPUTS, RESPONDS TO THE INPUTS BY EVALUATING THE PROPER EQUATIONS, AND PRINTS OUT A HISTORY OF THE CAUSE-EFFECT RESPONSES.

THE FIRST PROGRAM IS CALLED THE DNS PREPROCESSOR, AND THE SECOND IS CALLED THE DNS SIMULATION PROGRAM. BASIC INPUTS TO THE DNS PREPROCESSOR ARE TWO SETS OF PUNCHED CARDS. EACH CARD OF SET 1 CONTAINS THE VARIABLE NAME AND SIX RESPONSE TIMES REPRESENTING THE MINIMUM, AVERAGE, AND MAXIMUM PICK UP AND DROP OUT TIMES OF EACH VARIABLE. (ON CALL THE SIMULATION PROGRAM WILL SELECT ONE OF THESE TIMES FOR PICK UP AND ONE FOR DROP OUT RESPONSE TIMES.) THE CARDS OF SET 2 WILL CONTAIN THE LOGIC EQUATIONS DESCRIBING THE PHYSICAL INTERDEPENDENCIES. EXECUTION OF THE PREPROCESSOR WILL CAUSE,

- | | |
|---|-----------|
| 1. SET 1 (CALLED NAME AND TIME CARDS) TO BE READ IN, | INPUT |
| 2. THE NAMES PUT IN A NAME TABLE, | EXECUTION |
| 3. EACH TIME CONVERTED TO BINARY AND | EXECUTION |
| 4. PUT INTO ITS APPROPRIATE TIME TABLE, | EXECUTION |
| 5. THE NAME TABLE STORED ON MAGNETIC TAPE, | OUTPUT |
| 6. THE SIX TIME TABLES STORED ON MAGNETIC TAPE, | OUTPUT |
| 7. SET 2 (CALLED EQUATION CARDS) ARE READ IN, | INPUT |
| 8. THE EQUATIONS ARE CODED AND STORED IN THE EQUATION TABLE, | EXECUTION |
| 9. THE EQUATION TABLE IS STORED ON TAPE, | OUTPUT |
| 10. REFERENCE TABLES ARE CREATED FOR VARIABLE LOOK UP IN SIMULATION (IN ORDER THAT ONLY THOSE EQUATIONS ARE REFERENCED WHICH ARE THE EFFECTS OF A PARTICULAR VARIABLE), | EXECUTION |
| 11. THE REFERENCE TABLES ARE STORED ON TAPE, | OUTPUT |
| *12. NAMES SYNONYM OR DICTIONARY CARDS (IF PRESENT) ARE READ IN, | INPUT |
| *13. DICTIONARY CARDS ARE STORED ON TAPE, | OUTPUT |
| 14. PROGRAM EXITS FROM THE COMPUTER. | |

STEPS 12 AND 13 ARE NOT REQUIRED AND ARE USED ONLY IF A SPECIAL METHOD OF OUTPUT CALLED TRANSLATION IS TO BE USED DURING SIMULATION. THIS WILL BE DISCUSSED LATER.

THE TABLES ARE STORED ON A MAGNETIC TAPE CALLED THE 'BINARY MODEL TAPE'. IN ADDITION TO THE BINARY MODEL TAPE, EACH DATA CARD IS PRINTED AND FOR ANY

ERRORS ENCOUNTERED WHILE PROCESSING THAT CARD AN ERROR MESSAGE WILL BE PRINTED.

BASIC INPUTS TO THE SIMULATION PROGRAM ARE SIMULATION CONTROL CARDS AND ACTIVITY INPUTS. THE CONTROL CARDS ARE USED TO SPECIFY OUTPUT FORMATS, CASE CONTROL, AND SIMULATION OPTIONS. THE ACTIVITY INPUTS SPECIFY THE INITIAL CAUSING EVENTS, FORCING FUNCTIONS, AND/OR MALFUNCTIONS OR DEVIATIONS FROM NORMAL PROCESSING. THE BASIC OUTPUTS ARE THE SIMULATION HISTORY AND REQUESTED STATE LISTS.

IN GENERAL EXECUTION OF THE DNS SIMULATOR PROGRAM WILL CAUSE...

1. THE INPUTS ARE READ AND CONVERTED TO MACHINE ASSIMILABLE FORM WHILE BEING CHECKED FOR ERRORS. (EXECUTION IS HALTED IF ERRORS ARE FOUND.)
2. THE CONVERTED INPUTS ARE READ IN AND PROCESSED ONE AT A TIME IN THREE STEPS...
 - STEP A. THE PROLOGUE CARDS ARE READ.
THESE CARDS GIVE THE PROGRAM INFORMATION TO ENABLE IT TO PREPARE FOR SIMULATION. FOR EXAMPLE, THE MODEL IS CALLED FOR AND STORED IN COMPUTER MEMORY, FORMATS FOR OUTPUT ARE ESTABLISHED, ETC.
 - STEP B. DATA CARDS ARE READ IN UNTIL A CASE END IS DETECTED (IN WHICH CASE GO TO 3.) OR UNTIL
 - STEP C. A TERMINATION CARD (SIMULATION END OF DATA CARD) IS ENCOUNTERED, IN WHICH CASE THE SIMULATION IS ENDED.
3. A CASE IS PROCESSED AS FOLLOWS...
 - STEP A. ALL DATA INPUTS FOR THE CASE ARE PUT IN AN ACTION TABLE.
 - STEP B. THE ACTION TABLE IS SEARCHED FOR THE EARLIEST OCCURRING EVENT IN TIME (IF SEVERAL EVENTS ARE ENCOUNTERED WHICH ACT AT THE SAME TIME THE FIRST ENCOUNTERED IS SELECTED).
 - STEP C. THE EVENT COMPOSED OF VARIABLE NAME, STATE, AND TIME IS CHECKED TO SEE IF IT IS LEGAL (THIS STEP IS BYPASSED IF THE EVENT IS AN INPUT), IF NOT RETURN TO STEP B.
 - STEP D. THE STATE OF THE VARIABLE IS SET IN THE VALUE TABLE AND THE EVENT (NAME, STATE, AND TIME) IS PRINTED OUT.
 - STEP E. THE REFERENCE TABLES ARE USED TO LOCATE ALL EQUATIONS IN WHICH THIS EVENT CAN CAUSE A REACTION (I.E., THIS VARIABLE NAME OCCURS ON THE RIGHT HAND SIDE OF THE EQUAL SIGN IN AN EQUATION). IF NONE GO TO STEP I.
 - STEP F. EACH REFERENCED EQUATION IS EVALUATED AND IF A CHANGE OF STATE RESULTS AN EVENT IS CREATED, CONSISTING OF VARIABLE NAME, REACTION TYPE (PICK UP OR DROP OUT), NEW STATE, AND PREDICTED RESPONSE TIME (CURRENT TIME PLUS PICK UP OR DROP OUT TIME). THIS EVENT IS PUT IN A REACTION TABLE.
 - STEP G. WHEN ALL REFERENCED EQUATIONS HAVE BEEN EVALUATED, THE REACTION TABLE, IF DESIRED IS PRINTED OUT. IF THERE

- ARE NO REACTIONS GO TO STEP I.
- STEP H. THE ACTION AND REACTION TABLES ARE MERGED.
- STEP I. IF ACTIONS REMAIN IN THE ACTION TABLE THE PROGRAM RETURNS TO STEP B OF 3 FOR FURTHER ACTION AND BEHAVIORAL HISTORY. IF NO ACTIONS REMAIN THE PROGRAM KNOWS THE CASE IS OVER AND RETURNS TO STEP B OF 2 TO GET THE NEXT CASE.

THE USE AND NATURE OF THESE PROGRAMS IS BEST SEEN BY FOLLOWING THROUGH THE EXAMPLE GIVEN IN THE NEXT SECTION.

EXAMPLE OF DNS SIMULATION

CONSIDER THE FOLLOWING SIMPLE EXAMPLE BRINGING ELECTRIC POWER FROM A POWER STATION TO A HOUSE IN ORDER THAT A LAMP AND A RADIO CAN BE TURNED ON. IN ORDER TO ATTACK THIS PROBLEM THERE ARE THREE BASIC STEPS..

- I. ANALYSIS
- II. MODEL CONSTRUCTION
- III. SIMULATION

I. ANALYSIS PROCEEDS IN FOUR STAGES..

- A. DETERMINE THE BASIC ELEMENTS TO BE CONSIDERED.
- B. ESTABLISH THE ELEMENT RELATIONSHIPS.
- C. DEFINE THE TIMING REQUIREMENTS.
- D. DEVELOP THE FORCING FUNCTION TO DRIVE THE MODEL (IMPLIES DEFINITION OF SIMULATOR INPUTS, AND POSSIBLY BUILDING PART OF THE FORCING FUNCTION INTO THE MODEL, LIKE A CLOCK PULSE).

BASIC ELEMENTS AND THEIR RELATIONSHIPS IN TERMS OF ACTIONS PERFORMED AND CURRENT FLOW WERE CHOSEN AS FOLLOWS..

ENGINEER AT THE POWER HOUSE THROWS THE *MAIN SWITCH* TO THE
 (ENG) (MSWT)
 GENERATOR WHICH WHEN IT COMES UP TO SPEED SUPPLYING POWER TO THE
 (GEN)
 POWER LINE WHICH SUPPLIES POWER TO THE *HOUSE LINE* . IF THE
 (PLINE) (HLINE)
 HOUSE OWNER TURNS ON THE *CIRCUIT SWITCH* ON THE WALL THEN *PLUG 1*
 (CSWT) (PLUG1)
 TO WHICH THE RADIO IS CONNECTED WILL BE HOT, AND LIKE WISE *PLUG 2*
 (PLUG2)
 TO WHICH THE LAMP IS CONNECTED. IF THE OWNER TURNS ON THE *SWITCH*
 (RSWT)
 TO THE *RADIO* THE RADIO WILL PRODUCE *SOUND* AFTER A WARMUP PERIOD.
 (RADIO) (SOUND)
 IF THE OWNER TURNS ON THE *SWITCH* TO THE *LAMP* THE *BULB* WILL
 (LSWT) (LAMP) (BULB)
 PRODUCE *LIGHT* .
 (LIGHT)

A LISTING OF THE ELEMENTS, THEIR SIMULATION SYMBOLS, VARIABLE TYPES, AND ESTIMATED TIMING CAN NOW BE MADE...

ELEMENTS	SYMBOL	TYPE	PICK UP TIME	DROP OUT
ENGINEER	ENG	INPUT	0	0
MAIN SWITCH	MSWT	ELEMENT	3 SEC. (BIG SWITCH)	0
GENERATOR	GEN	ELEMENT	2 MIN. (GET IT GOING)	1 MIN.

POWER LINE	PLINE	OUTPUT, MED 20 MSEC. (TRANSFORMER TIME)	0
HOUSE LINE	HLINE	ELEMENT	0
CIRCUIT SWITCH	CSWT	INPUT	0
PLUG 1	PLUG1	OUTPUT, MED 2 SEC. (TIME TO THROW SWITCH)	0
RADIO	RADIO	ELEMENT	0
RADIO SWITCH	RSWT	INPUT	0
SOUND	SOUND	OUTPUT 10 SEC. (WARM UP TIME)	1 SEC.
PLUG 2	PLUG2	OUTPUT, MED 2 SEC.	0
LAMP	LAMP	ELEMENT	0
LAMP SWITCH	LSWT	INPUT	0
BULB	BULB	CONTROL	0
LIGHT	LIGHT	OUTPUT 100 MSEC (WARM UP TIME)	1 MSEC.

NOTE. NO EFFORT WILL BE MADE TO DISPLAY EXACT FORMATS AS THIS IS JUST AN EXAMPLE. FULL DETAILS WILL BE GIVEN IN LATER SECTIONS. THUS THE TIMES GIVEN ARE ARBITRARY AND ASSUMED NORMAL. NO EFFORT IS MADE TO DEPICT MINIMUM OR MAXIMUM PICK UP OR DROP OUT TIMES.

THE THREE DROP OUT TIMES, AS IS OBVIOUS, ARE SIMPLY DECAY TIMES FOR THE ELEMENTS INVOLVED. IT IS APPARENT FROM A QUICK LOOK AT THE TABLE ABOVE THAT IN THIS CASE THE WORK OF DEFINING THE FORCING FUNCTION HAS LARGELY BEEN DONE. THE COLUMN FOR VARIABLE TYPE TELLS US WE ARE GOING TO DRIVE THE MODEL WITH THE FOUR INPUTS OF ENGINEER (ENG), CIRCUIT SWITCH (CSWT), RADIO SWITCH (RSWT), AND LAMP SWITCH (LSWT). THE FINAL RESULTS OR EFFECTS WILL BE WHEN SOUND OR LIGHT APPEARS. THERE ARE THREE MEDIARY ENDPOINTS, BEYOND WHICH FURTHER ACTION IS REQUIRED. THESE ARE HOUSE LINE (HLINE) TO WHICH CURRENT HAS BEEN SUPPLIED, AND THE TWO PLUGS. ALL THREE REQUIRE MANUAL ACTION.

II. FOLLOWING ANALYSIS THE NEXT STEP IS TO CONSTRUCT THE MODEL IN A FORM SUITABLE FOR INPUT TO THE SIMULATION PROGRAM. THE SYMBOL NAMES AND TIME VALUES ARE PUT ON PUNCHED CARDS IN THE FORMAT DESCRIBED IN THE SECTION ON PREFPROCESSOR DATA FORMATS. IN THIS STEP THE CRITICAL TASK IS TO WRITE THE LOGIC EQUATIONS AND DECIDE ON THE INTERPRETATION OF THE VARIABLE VALUES OR STATES. IN THE SAMPLE PROBLEM ONLY A TWO STATE LOGIC IS REQUIRED AND THE SIMULATION PROGRAM WILL PRINT OUT EITHER ONE (1) OR ZERO (0). ONE IN THE SAMPLE WILL MEAN ACTION PERFORMED OR CURRENT AVAILABLE. ZERO WILL MEAN NO ACTION OR NO CURRENT. IN THIS MODEL ONLY TWO OPERATORS ARE REQUIRED. THE AND (WRITTEN *) OPERATOR WILL MEAN THAT ELEMENTS SO CONNECTED MUST BOTH BE ONE (1) BEFORE THE CONDITION WILL BE SATISFIED. THE OR (WRITTEN +) OPERATOR WILL MEAN THAT AT LEAST ONE OF THE ELEMENTS SO CONNECTED MUST BE ONE (1) FOR A RESULT TO BE ONE (1). THE PUNCTUATION USED IS AS FOLLOWS...

AN EQUAL SIGN = MEANS EVALUATE THE EXPRESSION TO THE RIGHT AND GENERATE AN EVENT BEARING THE VARIABLE NAME TO THE LEFT AT CURRENT TIME PLUS THE PICK UP TIME (IF GOING FROM 0 TO 1) OR PLUS THE DROP OUT TIME (IF GOING FROM 1 TO 0), IF AND ONLY IF THE STATE OF THAT VARIABLE

IS CHANGING. THE VARIABLE NAME TO THE LEFT
 OF AN EQUAL SIGN IS CALLED A FUNCTION NAME.
 PARENTHESES () ARE USED TO DESIGNATE SPECIAL COMBINATIONS
 OF VARIABLES AND OPERATORS.
 A PERIOD . TERMINATES AN EQUATION.

WITH THIS INFORMATION WE CAN WRITE THE MODEL EQUATIONS AS FOLLOWS...

```
MSWT = ENG.
GEN  = MSWT.
PLINE = GEN.
HLINE = PLINE.
PLUG1 = HLINE * CSWT.
RADIO = PLUG1.
SOUND = RADIO * RSWT.
PLUG2 = HLINE * CSWT.
LAMP  = PLUG1.
BULB  = LAMP * LSWT.
LIGHT = BULB.
```

THESE EQUATIONS ARE PUNCHED ON CARDS AND TOGETHER WITH THE NAME
 AND TIME CARDS ARE INPUT TO THE DNS PREPROCESSOR PROGRAM. THE RESULT IS AS
 FOLLOWS...

INPUT..NAME AND TIME CARDS
 ..EQUATION CARDS

EXECUTION..DNS PREPROCESSOR ON IBM 7094 COMPUTER

OUTPUT..PRINTED LIST OF INPUTS WITH ERRORS FLAGGED
 IF ANY
 ..BINARY MODEL TAPE CONTAINING ALL CONVERTED
 INFORMATION AND REFERENCE TABLES

III. IF THERE ARE NO ERRORS, THE FINAL STEP IS SIMULATION. TYPICAL INPUT
 MIGHT APPEAR AS FOLLOWS..

COLS.

```
0000000001111111112222222223.....
123456789012345678901234567890.....
*TITLE      THIS IS A SAMPLE PROBLEM.
*LOGICAL MODE,02,05.    (02 = AVERAGE PICK UP, 05 = AVERAGE DROPOUT
*                      TIME TABLES)    (COMMENT CARD)
*BEGIN.      CASE 1  BRING UP POWER
      ENG = 1 AT 0.
*BEGIN.      CASE 2  SET HOUSE CURRENT PLUGS HOT
      CSWT      = 1 AT 50M.
*BEGIN.      CASE 3  TURN ON LAMP
```

```

      LSWT = 1   AT 51 M.
*BEGIN.      CASE 4  TURN ON RADIO
      RSWT = 1   AT 53 M.
*BEGIN.      CASE 5  LAMP BURNS OUT..FAILURE.
      LAMP = 0   AT 55 M.
*$$$$$      JOB END CARD.

```

FOR PURPOSES OF ILLUSTRATION THIS SAMPLE IS BROKEN INTO FIVE CASES, BUT COULD AS EASILY BEEN ONE CASE WITH THE VARIOUS ACTION CARDS GATHERED TO COMPRISE ONE CASE. THE CARDS WITH AN ASTERISK IN COLUMN 1 ARE CALLED CONTROL CARDS-THE REST ARE DATA.

TYPICAL PRINTED OUTPUT FROM THE COMPUTER WOULD FIRST PRINT THE INPUTS WITH ANY ERROR MESSAGES. IF NO ERRORS THE COMPUTER PROGRAM HISTORY PRINT WOULD FOLLOW AND APPEAR VERY MUCH AS FOLLOWS...

THIS IS A SAMPLE PROBLEM

PAGE 1

*LOGICAL MODE,02,05.

*

TYPE	DESCRIPTION	VALUE	NO. OF EVENTS	DAYS	HOURS	MINUTES	SECONDS
*BEGIN.	CASE 1	BRING UP POWER					
INPUT	ENG	1	1				.000
	MSWT	1					3.000
ENTER	MSWT	1	1				3.000
	GENT	1				2	3.000
ENTER	GENT	1	1			2	3.000
	PLINE	1				2	3.020
ENTER	PLINE	1	1			2	3.020
	HLINE	1				2	3.020
ENTER	HLINE	1	1			2	3.020

THIS IS A SAMPLE PROBLEM

PAGE 2

TYPE	DESCRIPTION	VALUE	NO. OF EVENTS	DAYS	HOURS	MINUTES	SECONDS
*BEGIN.	CASE 2	SET HOUSE PLUGS HOT					
INPUT	CSWT	1	1			50	.000
	PLUG1	1				50	2.000
	PLUG2	1				50	2.000
ENTER	PLUG1	1	2			50	2.000

	RADIO	1		50	2.000
ENTER	PLUG2	1	2	50	2.000
	LAMP	1		50	2.000
ENTER	RADIO	1	2	50	2.000
ENTER	LAMP	1	1	50	2.000

THIS IS A SAMPLE PROBLEM

PAGE 3

TYPE	DESCRIPTION	VALUE	NO. OF EVENTS	DAYS	HOURS	MINUTES	SECONDS
*BEGIN.	CASE 3	TURN ON LAMP					
INPUT	LSWT	1	1			51	.000
	BULB	1				51	.000
ENTER	BULB	1	1			51	.000
	LIGHT	1				51	.100
ENTER	LIGHT	1	1			51	.100

THIS IS A SAMPLE PROBLEM

PAGE 4

TYPE	DESCRIPTION	VALUE	NO. OF EVENTS	DAYS	HOURS	MINUTES	SECONDS
*BEGIN.	CASE 4	TURN ON RADIO					
INPUT	RSWT	1	1			53	.000
	SOUND	1				53	10.000
ENTER	SOUND	1	1			53	10.000

THIS IS A SAMPLE PROBLEM

PAGE 5

TYPE	DESCRIPTION	VALUE	NO. OF EVENTS	DAYS	HOURS	MINUTES	SECONDS
*BEGIN.	CASE 5	LAMP BURNS OUT, FAILURE.					
INPUT	LAMP	0	1			55	.000
	BULB	0				55	.000
ENTER	BULB	0	1			55	.000
	LIGHT	0				55	.001
ENTER	LIGHT	0	1			55	.001

\$\$\$\$\$ JOB END CARD.

IF AT THE END OF CASE 5 A 'LIST' HAD BEEN CALLED, THE FOLLOWING OUTPUT WOULD APPEAR...

```
*LIST AT      3300001.      NO.    1
ENG           =    1.
MSWT          =    1.
GEN           =    1.
PLINE         =    1.
HLINE         =    1.
CSWT          =    1.
PLUG1         =    1.
RADIO         =    1.
RSWT          =    1.
SOUND         =    1.
PLUG2         =    1.
LAMP          =    0.
LSWT          =    1.
BULB          =    0.
LIGHT         =    0.
*END LIST.

*ACTIONS      NO.    0
*END ACTIONS
```

THE FOLLOWING EXPLANATORY COMMENTS ARE IN ORDER...

- PRINT LINES IN THE HISTORY CONTAINING A VARIABLE NAME ARE CALLED ACTIVITIES. THOSE ACTIVITIES WITH TEXT (SUCH AS THE WORD 'INPUT' OR 'ENTER') ARE CALLED EVENTS, OR ACTIONS. SUCH EVENTS REPRESENT THE BEHAVIOR OF THE MODEL. ACTIVITIES WITH NO TEXT UNDER THE 'TYPE' COLUMN ARE CALLED REACTIONS, OR PREDICTED EVENTS. THESE ARE PREDICTIONS OF BEHAVIOR TO OCCUR AT A LATER POINT IN TIME. THEY MAY OR MAY NOT 'COME TRUE' DEPENDING ON THE STATE OF THE VARIABLES IN THE MODEL AT THE PREDICTED TIME.
- THE NUMBER OF EVENTS COLUMN RECORDS THE NUMBER OF ACTIONS WAITING TO BE PROCESSED IN THE ACTION TABLE, INCLUDING THE EVENT PRINTED OUT.
- A LIST CAN BE CALLED FOR AT ANY TIME, NOT JUST AT THE END OF A CASE. IF A LIST IS CALLED FOR AT A TIME WHEN THERE ARE STILL ACTIONS IN THE ACTION TABLE, THEN THE CURRENT CONTENTS OF THE ACTION TABLE IS PRINTED OUT.

BY NOW A GENERAL FEELING FOR THE PROGRAMS AND THE SIMULATION CAPABILITY SHOULD BE IN THE READERS GRASP. THE PROGRAMS POSSESS MANY MORE OPTIONS THE DETAILS OF WHICH WILL BE FOUND IN THE REST OF THE MANUAL.

SUMMARY OF DNS SIMULATION

HAVING SEEN THE PROBLEM STATEMENT, THE SOLUTION DEFINITION, SOLUTION IMPLEMENTATION, AND A SIMULATION EXAMPLE, IT WILL BE USEFUL TO REVIEW THE SIMULATION PROCEDURE IN SUMMARY. THE FOLLOWING CHART DISPLAYS THE DATA AND PROCEDURE FLOW.

ANALYSIS	EXECUTION	OUTPUT
.....
.DEFINE VARIABLES .	.PREPROCESSOR .	.....
. NAME .	. PROGRAM .	.ERROR CHECKED INPUT.
. TIMING, PICK UP AND .	. ON .	.....
. DROP OUT .	.....7094 COMPUTER .	.....
. STATE (0/1) INTERPRETATION. .	. (CONVERT MODEL .	.....
.DEFINE VARIABLE RELATIONS .	. DESCRIPTION) .	.BINARY MODEL TAPE .
. IN LOGIC EQUATIONS .	. .	.....
.....
.....
. DEFINE FORCING FUNCTION .	. SIMULATION .	.....
. PRESET CONDITIONS .	. PROGRAM .	.....
. INITIATING ACTIONS .	. ON .	..... BEHAVIOR HISTORY. .
. EXTERNAL ACTIONS .	.7094 COMPUTER .	.....
.....	. (MODEL EVAL- .	.....
.....	. UATION, AND. .	.....
.....	. EVENT TIMING).....	. STATE LISTS .
. BINARY MODEL TAPE .	.....	.....
.....
.....

DATA DESCRIPTION, THE DNS PREPROCESSOR

DATA DECK ARRANGEMENT

THE TYPICAL DATA DECK SETUP APPEARS AS BELOW..

```

0000000001111111112222222223.....
123456789012345678901234567890.....

*TITLE  (COLS. 7-80 OF THIS CARD IS PRINTED ON EVERY PAGE.)
*       (COLS. 7-80 IS A COMMENT PRINTED AS IT OCCURS.)
*
*TIMES
      N A M E      A N D      T I M E      D A T A      C A R D S
*END TIMES
*EQUATIONS
      E Q U A T I O N      D A T A      C A R D S
*END EQUATIONS
*NAMES  (INCLUDE THE NAMES SECTION IF DESIRED.)
      N A M E      D A T A      C A R D S
*END NAMES
*$$$$$ (END OF DATA CARD.)

```

AS IS APPARENT FROM LOOKING AT THE ABOVE REPRESENTATION OF A PREPROCESSOR DATA DECK, THERE ARE FIVE ORDERED PARTS TO ANY SUCH DECK. TWO OF THESE PARTS ARE OPTIONAL.

PART 1.	PROLOGUE..TITLE AND COMMENTS	(OPTIONAL)
PART 2.	NAME AND TIMES..*TIMES NAME AND TIMES DATA *END TIMES	(REQUIRED)
PART 3.	EQUATIONS..*EQUATIONS EQUATION DATA *END EQUATIONS	(REQUIRED)
PART 4.	NAMES..*NAMES NAMES DATA *END NAMES	(OPTIONAL)
PART 5.	TERMINATION..*\$\$\$\$\$	(REQUIRED)

THERE ARE TWO CLASSES OF DATA FOR THE PREPROCESSOR. CONTROL CARDS ARE DISTINGUISHED BY AN ASTERISK (*) IN COLUMN 1. THE OTHER CLASS OF COURSE IS THE DATA ITSELF. IT IS REQUIRED THAT PARTS 2, 3, AND 5 APPEAR IN THE DATA DECK WITH THE CONTROL CARDS INDICATED AS THEY APPEAR ABOVE. EACH PART

WILL BE DISCUSSED IN TURN BELOW.

PART 1 PROLOGUE

THE TITLE AND ASSOCIATED COMMENTS ARE MERELY FOR THE CONVENIENCE OF THE MODELER. THEY HELP TO COMMENT OR IDENTIFY THE RUN. COMMENT CARDS MAY APPEAR ANYWHERE IN THE DATA AS WELL AS AT THE START OF A DATA DECK. LIBERAL USE OF COMMENTS IS BENEFICIAL TO THE MODELER AS THEY HELP TO ORGANIZE AND DOCUMENT THE MODEL.

PART 2 NAME AND TIMES

THE NAME AND TIME CARDS SERVE TWO FUNCTIONS. FIRST, THE ORDER OF THE NAMES PROVIDES THE ORDER OF THE INTERNAL CODES ASSIGNED TO EACH VARIABLE IN THE EQUATIONS. THIS MEANS THAT A MEANS OF GIVING INFORMATION TO THE SIMULATOR ABOUT SETS OF VARIABLES IS POSSIBLE. SECONDLY, THESE CARDS SPECIFY THE PICK UP AND DROP OUT RESPONSE TIMES FOR EVERY VARIABLE IN THE MODEL. A NAME AND TIME CARD MUST APPEAR FOR EVERY VARIABLE NAMED IN AN EQUATION. THE LIMIT ON THE NUMBER OF VARIABLE NAMES IS 2600.

DATA FORMATS ARE	NAME	COLS. 1- 6 MAY USE A-Z,0-9
	TIME 1	COLS. 13-18
	TIME 2	COLS. 19-24
	TIME 3	COLS. 25-30
	TIME 4	COLS. 37-42
	TIME 5	COLS. 43-48
	TIME 6	COLS. 49-54

THE TIME TYPE CHARACTER APPEARS IN COLUMNS 13,19,25,37,43, AND 49, AND MUST BE ONE OF H (HOURS),

M (MINUTES),

OR S (SECONDS).

THE REMAINDER OF EACH FIELD IS A DECIMAL NUMBER WITH A DECIMAL POINT ASSUMED BETWEEN THE 3RD AND 4TH COLUMNS OF EACH FIELD.

A TYPICAL TIME CARD IS

```
00000000011111111122222222233333333334444444445555555556
123456789012345678901234567890123456789012345678901234567890
```

```
POWER          S 2500M 2000H 1000          S    1S  500M 1500
```

THE NAME OF THE VARIABLE IS 'POWER',

TIME 1 IS 2 SECONDS 500 MILLISECONDS (OR 2 1/2 SECONDS),

TIME 2 IS 2 MINUTES,

TIME 3 IS 1 HOUR,

TIME 4 IS 1 MILLISECOND,

TIME 5 IS 500 MILLISECONDS (OR 1/2 SECOND),

TIME 6 IS 1 1/2 MINUTE.

THIS EXAMPLE POINTS UP THE FACT THAT THE TIME BASE IS THE MILLISOND.

IN ADDITION IF ONE OR MORE OF THE TIME FIELDS IS LEFT BLANK THEN THE TIME VALUE FOR THAT FIELD FROM THE PREVIOUS CARD IS USED.

PART 3 EQUATIONS

THE EQUATIONS ARE IN THE FORM 'A = B.' ONE VARIABLE NAME APPEARS TO THE LEFT OF THE EQUAL SIGN (=), 'B' IS AN EXPRESSION, AND THE PERIOD (.) MUST BE PRESENT TO TERMINATE THE EQUATION.

AN EXPRESSION IS ANY COMBINATION OF NAMES, OPERATORS, AND PARENTHESES. THE OPERATORS ARE

AND *
OR +
NOT /.

THESE ARE LOGICAL OPERATORS (BOOLEAN) AND WILL BE EVALUATED ACCORDING TO THE FOLLOWING TRUTH TABLE...

A	B	A * B	A + B	/A
0	0	0	0	1
0	1	0	1	1
1	0	0	1	0
1	1	1	1	0

A SUM OF PRODUCTS FORM OF EVALUATION WILL BE USED IN THE SIMULATOR.

THE EQUATIONS ARE WRITTEN IN COLUMNS 1-72 OF A CARD, AND AS MANY CARDS AS NECESSARY FOR THE EQUATION MAY BE USED. COLUMNS 73-80 ARE USED FOR IDENTIFICATION. BLANKS MAY BE FREELY USED.

TYPICAL EXAMPLES OF EQUATIONS ARE...

RELAY1 = COILA * VOLT28.

B = C + D*A.

A = 3*2 + 5* (7+J).

FAIL = / GOOD.

GO = TIME * / ((C+D) * QT + /M *N) + NOW.

PART 4 NAMES

USE OF THIS SECTION SIMPLY CAUSES THE NAME CARDS TO BE PLACED ONE CARD IMAGE AT A TIME IN AN ELEVENTH FILE ON THE BINARY MODEL TAPE. REQUIRED FORMATS ARE DEFINED BY THE SIMULATION PROGRAM TRANSLATION MODE.

NAME DATA CARD FORMAT IS 6-CHARACTER NAME IN COLS. 1- 6
SYNONYM NAME IN COLS. 13-36

(NOTE NO CHECKING OF NAMES IS DONE, AS THIS OPTION IS INTENDED FOR USE WITH THE DTC PROGRAM.) THE NUMBER OF NAMES IN THE NAMES DECK NEED NOT BE THE SAME AS THE NUMBER OF TIME CARDS.

PART 5 TERMINATION

THIS PART SIMPLY CLOSES THE DATA DECK.

DATA DESCRIPTION, THE SIMULATOR

ACTION DATA DESCRIPTION...

CONTROL CARDS ARE USED TO DETERMINE THE TYPE OF SIMULATION. THE CARDS TO BE DESCRIBED BELOW ARE OF SEVERAL KINDS BUT THEY HAVE THE CHARACTERISTIC THAT THEIR EFFECT IS ON THE HISTORY AND IS IN TIME. THE DICTIONARY DATA CARDS MODIFY VARIABLE NAMES OR AFFECT THEIR VALUES. THE ACTION COMMAND CARDS AFFECT THE VALUE TABLE PRIMARILY, ALTHOUGH THE RANGE OF APPLICATION IS EXPANDING TO INCLUDE CONTROLS WHICH NEED TO BE APPLIED IN TIME. THE VARIABLE INPUT CARDS OPERATE DIRECTLY ON THE MODEL.

I. VARIABLE EVENT INPUT CARDS

THESE ARE THE CARDS WHICH DRIVE THE MODEL IN TIME. THE TIME SPECIFIED ON THE EARLIEST SELECTED CARD OF A CASE SETS THE CLOCK. THE SIMULATION CLOCK IS THEN MODIFIED AS DEFINED BY EVENT PICK UP AND DROP OUT TIMES AS CALLED FOR BY THE EQUATION DEPENDENCIES.

A. VARIABLE EVENT INPUT CARDS

FORMAT. FREE FIELD, BLANKS MAY BE FREELY INTERSPERSED.

THE GENERAL FORM IS

NAME = VALUE AT TIME.

NAME = A VARIABLE NAME, 1-6 CHARACTERS IN LENGTH USING A-Z, 0-9.

VALUE = 0, 1, 0.0, 1.0, OR ANY NUMBER OF THE FORM M.N

TIME = TIME OF ACTION AND IS OF THE FORM

ND NH NM NS NL, WHERE

N = AN INTEGER SPECIFYING THE NUMBER OF UNITS OF THE TIME SPECIFIED BY THE CHARACTER TO THE RIGHT OF THE INTEGER. THE ALLOWED CHARACTERS AND THEIR MEANINGS ARE

D = DAYS

H = HOURS

M = MINUTES

S = SECONDS

L = MILLISECONDS

THE TIME SPECIFICATION MAY BE ORDERED IN ANY FASHION, ANY OR ALL OF THE UNITS MAY BE LEFT OUT, AND BLANKS MAY BE INTERSPERSED. IF ONLY AN INTEGER IS PRESENT THEN THE TIME IS ASSUMED TO BE IN MILLISECONDS.

EXAMPLES FOLLOW...

A = 1.0 AT 1D.

B = 1.0 AT 24H.

C = 1.0 AT 1D 6H 45M 38 S 572 L.

D = 1 AT 9.

THUS THE FIRST TWO EVENTS ARE EQUIVALENT. EVENT C WILL TAKE PLACE AT THE END OF 1 DAY, 6 HOURS, 45 MINUTES, 32 SECONDS AND 572 MILLISECONDS. D WILL TAKE PLACE AT 9 MILLISECONDS. NOTE...A '.' (PERIOD) MUST APPEAR AT THE END.

USAGE. THESE CARDS ARE THE ACTIVITY INPUTS TO THE SYSTEM BEING SIMULATED. THEY MAY REPRESENT STARTING EVENTS (BUTTON PUSHING), INITIATING EVENTS FROM A PRE-SET SYSTEM, OR MALFUNCTIONS.

B. CHANGE TIME INPUT CARD

FORMAT. FREE FIELD, ALTERNATIVE VERSIONS ARE GIVEN BELOW.

THE GENERAL FORM IS

NAME, AT TIME, X, DELAY.

THE PUNCTUATION MUST APPEAR.

NAME = SAME AS ON EVENT INPUT CARD.

TIME = SAME AS ON EVENT INPUT CARD. THE WORD 'AT' MUST PRECEDE THE TIME.

X = ONE OF P FOR PICKUP TIME (REFERENCES TIME TABLE 1)

OR D FOR DROP OUT TIME (REFERENCES TIME TABLE 2)

DELAY= THE TIME DELAY TO BE INSERTED IN THE SPECIFIED TIME TABLE. ITS FORMAT IS IDENTICAL TO 'TIME' OR MAY BE THE CHARACTER 'I' SPECIFYING INFINITY.

EXAMPLES FOLLOW...

A, AT 45 M 32S, P, 500L.

VARYIT, AT 1H, D, 30M 30S.

B, AT 1H, P, I.

A WILL CHANGE ITS PICK UP TIME TO 500 MILLISECONDS AT 45 MINUTES AND 32 SECONDS, BUT AT 1 HOUR B WILL BE PREVENTED FROM EVER PICKING UP. VARYIT WILL HAVE ITS DROP OUT TIME CHANGED AS SPECIFIED.

THESE CHANGES WILL HOLD FOR THE LIFE OF A CASE, UNLESS SUPERCEDED BY A LATER INPUT IN THE SAME CASE.

USAGE. THESE CARDS CHANGE THE REFERENCED TIME TABLE ENTRIES FOR THE VARIABLE SPECIFIED, FOR THE LIFE OF THE CASE. THIS PROVIDES A MEANS FOR INSERTING TIME DELAYS INTO THE MODEL OR FOR PREVENTING A VARIABLE FROM ACTING AT ALL.

II. VARIABLE PARAMETER DATA CARDS

THESE DATA CARDS ARE ALL DEFINED AFTER SOME CONTROL CARD IS GIVEN.

*NAMES DATA CARD...

FORMAT. COL. 1- 6 SIX CHARACTER CODED MODEL NAME
COL. 13-36 THE CORRESPONDING TRANSLATION MODE NAME

USAGE. THIS CARD IS USED IN CONJUNCTION WITH THE *TRANSLATION
MODE AND ITS OPTIONS.

*VARIABLE PRINT NAME CARDS...

FORMAT. COL. 1- 6 SIX CHARACTER CODED VARIABLE NAME

USAGE. ONLY THE VARIABLES SPECIFIED WILL BE PRINTED OUT IN THE
HISTORY.

*NO VARIABLE PRINT NAME CARDS.

FORMAT. COL. 1- 6 SIX CHARACTER CODED VARIABLE NAME

USAGE. THE NAME SPECIFIED WILL BE DELETED IN ACTION PRINT OUTS
AND THE CORRESPONDING REACTION WILL BE DELETED ALSO.

SET MODE ACTIVITY CARDS...

FORMAT. VARIABLE = B.
VARIABLE MAY BE 1-6 CHARACTERS INCLUDING A-Z, 0-9.
THE EQUAL SIGN AND PERIOD MUST BE PRESENT.
B IS ONE OF 0 OR 1 IN *LOGICAL MODE,

USAGE. THESE CARDS OCCUR AS A BLOCK, ONE EQUATION PER CARD.
THEY ARE USED WITH THE *SET CARD AND SPECIFY THE VALUE
TO WHICH THE VARIABLE IS TO BE SET IN THE STATE TABLE.

*SET TERMINALS NAME CARD

FORMAT. COL. 1- 6 SIX CHARACTER CODED VARIABLE NAME.

USAGE. ANY VARIABLE APPEARING IN THIS DECK WILL BE TREATED AS A
TERMINAL, THAT IS, THE EQUATIONS IN WHICH IT IS USED WILL
NOT BE LOOKED UP DURING THE HISTORY. THESE CARDS WILL
REMAIN IN EFFECT THROUGHOUT A JOB.

III. ACTION COMMAND DATA CARDS

THESE CARDS ARE CONVERTED ON INPUT INTO A FORM LIKE THE VARIABLE EVENT
INPUT CARDS AND ARE THEREAFTER TREATED LIKE ACTION DATA. DUE TO THEIR NATURE,
THEIR TIME IS ADJUSTED TO INSURE THAT ALL ACTIONS TO OCCUR AT THE TIME SPECIFIED
ON THESE CARDS WILL HAVE OCCURRED. IT IS RECOMMENDED THEREFORE THAT DECK SET UP

FOR A CASE BE AS FOLLOWS.. CONTROL CARDS
ACTION COMMAND CARDS
VARIABLE EVENT INPUT CARDS

LIST AT TIME CARD...

FORMAT. COL. 1-12 *LIST AT
COL. 13-72 ND NH NM NS NL.
THE TIME SPECIFICATION FORMAT IS THE SAME
AS THE VARIABLE EVENT INPUT CARDS (Q.V.).

USAGE. THIS CARD CAUSES THE PRINTING OF A LIST OF ALL VARIABLES,
AND THEIR STATES, AT THE TIME SPECIFIED. AN INTERRUPT
OF THE SIMULATION HISTORY IS EFFECTED AT THE SIMULATION
TIME SPECIFIED. SIMULATION HISTORY CONTINUES
AFTER THE LIST IS COMPLETE.
IN ADDITION TO THE LIST THE CURRENT CONTENTS OF THE
ACTION TABLE ARE PRINTED. THUS A COMPLETE PICTURE OF
THE MODEL IS GIVEN AT AN INSTANT OF DYNAMIC TIME, THE
STATE OF EVERY ELEMENT OF THE MODEL AND THE EVENTS
WAITING TO TAKE PLACE ARE DISPLAYED. THIS FEATURE CAN
BE USED FOR DETAILED ANALYSIS OF MODEL BEHAVIOR OR
TO DETERMINE THE MODEL STATUS SO THAT A LATER RUN CAN
START FROM THE SPECIFIED POINT IN TIME, ELIMINATING
START UP FROM THE BEGINNING.

LIST PUNCH AT TIME CARD...

FORMAT. SAME AS THE LIST AT TIME CARD EXCEPT
COL. 6 P

USAGE. A LIST IS PUNCHED IN THE SAME FORMAT AS A 'SET' MODE
ACTIVITY CARD.
THE LIST IS BOTH PRINTED AND PUNCHED UNDER THIS OPTION.
A COMMON USE FOR THESE CARDS IS TO PRESET A SIMULATION RUN
TO ELIMINATE START UP AT THE BEGINNING. NOTE THAT IF THE
*LIST1 OPTION IS IN EFFECT THEN ONLY VARIABLES WITH A VALUE
OF NON-ZERO WILL BE PRINTED AND PUNCHED.

HALT AT TIME CARD...

FORMAT. COL. 1-6 *HALT
FOR THE REST OF THE FORMAT SEE THE LIST AT TIME CARD.

USAGE. THIS CARD CAUSES THE SIMULATION HISTORY TO TERMINATE
IF THE TIME SPECIFIED IS EXCEEDED IN THE HISTORY. A
STATE LIST OF ALL VARIABLES IS PRINTED BEFORE THE RUN
IS TERMINATED.

CONTROL CARD DESCRIPTION...

CONTROL CARDS ARE USED TO SPECIFY VARIOUS OPTIONS DURING SIMULATION. DETAILED DESCRIPTIONS OF EACH CONTROL CARD WILL BE FOUND IN THE 'ALPHABETICAL LIST OF CONTROL CARDS, THE SIMULATOR' IN THE APPENDIX. FURTHER REFERENCES TO CONTROL CARD CONTEXT IS GIVEN IN THE APPENDIX 'GUIDE TO CONTROL CARD USAGE, THE DNS SIMULATOR'.

A CONTROL CARD IS DISTINGUISHED BY AN ASTERISK (*) PUNCHED IN COLUMN 1 OF THE CARD. THE IDENTIFYING WORD MUST BE LEFT-JUSTIFIED TO THE ASTERISK. EXCEPT FOR THOSE CONTROL CARDS WITH SPECIFIED FIXED FIELDS ONLY THE FIRST FIVE CHARACTERS OF THE IDENTIFYING WORD ARE SIGNIFICANT. FOR EXAMPLE,

```
CARD COLUMN
000000000111111112...
12345678901234567890...
```

*SINGLE SPACE
AND *SINGL

ARE EQUIVALENT. THE EXCEPTIONS TO THIS ARE...

```
*BEGIN,T.
*BIAS,N.
*BINARY OUTPUT
*CONTROL TIME,T.
*LIST
*LOGICAL MODE,XX,YY.
*SELECT...11
```

NOTE THAT ANY SPACING REFERENCED IN THE CONTROL CARD LIST IS REQUIRED. FOR EXAMPLE, THE *LOGICAL MODE,XX,YY. CARD MUST BE WRITTEN AS SPECIFIED.

THE GENERAL USE OF CONTROL CARDS WILL BE DISPLAYED IN THE FOLLOWING SECTION.

DECK SETUP...

DECK SET UP IS MORE COMPLICATED IN THE SIMULATION PROGRAM. THE FOLLOWING DEFINITIONS WILL BE USEFUL.

RUN PREFACE ALL CONTROL CARDS PRECEDING THE FIRST JOB TYPE CARD.
THE FOLLOWING CONTROL CARDS MAY APPEAR IN THE PREFACE.

```

FORMAT      *SINGLE SPACE
            *SUPPRESS CONTROL CARDS
            *EJECT
            *NEW PAGE
            *TITLE
MISCELLANEOUS *DEBUG
            *
```

RUN ALL DATA CARDS FOLLOWING THE PROGRAM DECK. A RUN INCLUDES ONE OR MORE JOBS AND MAY INCLUDE ONE OR MORE CASES.

JOB ALL DATA CARDS FROM ONE JOB TYPE CONTROL CARD (*LOGICAL MODE) TO ANOTHER OR TO THE TERMINATION CARD (*\$\$\$\$).

CASE A CASE INCLUDES ALL CONTROL CARDS (A CARD WITH AN * IN COL. 1) FOLLOWED BY VARIABLE INPUT CARDS. A CASE ENDING IS SIGNALLED BY THE OCCURRENCE OF THE FIRST CONTROL CARD FOLLOWING A VARIABLE INPUT CARD.

THUS A TYPICAL DECK SET UP IS LAID OUT AS FOLLOWS WITH A SAMPLE.

RUN	SAMPLE
RUN PREFACE	RUN *TITLE THIS IS A SAMPLE
JOB 1	JOB 1 *LOGICAL MODE,01,04.
CASE 1	CASE1 *BEGIN.
CASE 2	A = 1 AT 0.
.	CASE2 *BEGIN.
.	B = 1 AT 200.
CASE N	JOB 2 *LOGICAL MODE,02,05.
JOB 2	CASE1 *BEGIN.
CASE 1	A = 1 AT 0.
CASE 2	CASE2 *BEGIN.
.	B = 1 AT 200.
.	C = 1 AT 205.
CASE N	END *\$\$\$\$
JOB 3	
.	
.	
JOB N	
TERMINATION CARD (*\$\$\$\$)	

THERE ARE TWO MOST MINIMUM USEFUL DATA SET-UPS.

*LOGICAL MODE,01,06. A = 1 AT 0. *\$\$\$\$\$	THIS DATA WILL PRODUCE A HISTORY PRINT OUT OF ALL ACTIVE EVENTS DEPENDING ON A.
*LOGICAL MODE,03,05. *LIST *\$\$\$\$\$	THIS REQUESTS A LIST OF ALL VARIABLE NAMES, THEIR SIMULATION ORDER AND THEIR OCTAL INDEX NUMBERS. (NOT REALLY VERY USEFUL.)

THE AVERAGE (AND THEREFORE TYPICAL) SIMULATION PROGRAM SET UP CAN BE DEPICTED AS FOLLOWS.

TYPE	DATA DECK	MEANING
RUN PREFACE	*TITLE RUN NO. 5,DATE,NAME * * THIS CASE IS A VALIDATION * RUN TESTING THE EQUATION * LOGIC FOR MANUAL SWITCHES	TITLE ON EVERY PAGE COMMENTS DESCRIBING THE CASE
JOB	*LOGICAL MODE,02,05.	JOB TYPE CARD, REQUEST NOMINAL REACTION TIMES.
CASE 1	*SET POW1 = 1. POW2 = 1. POW3 = 1. *END SET *SINGLE SPACE *BEGIN. Sw1 = 1 AT 0. *LIST	PRESET THE POWER SUPPLIES, I.E., PUT THE MODEL IN A STANDBY CONDITION. FORMAT CONTROL DATA FOLLOWS. VARIABLE INPUT, TEST FIRST SWITCH. DISPLAY MODEL ELEMENT STATES WHEN MODEL STOPS REACTING.
CASE 2	*RESET *BEGIN. Sw2 = 1 AT 0. *LIST	GO BACK TO STANDBY. VARIABLE INPUT, TEST ANOTHER MANUAL INPUT THIS LIST WILL PROBABLY BE COMPARED WITH THE LAST ONE.
CASE 3	*RESET *BEGIN. Sw1 = 1 AT 0. Sw2 = 1 AT 0. Sw3 = 1 AT 200. *LIST	TEST FOR EFFECTS OF ALL SWITCHES AND ADD ANOTHER.
TERMINATION	*\$\$\$\$\$	END THE RUN

THIS HAS BEEN AN EXAMPLE OF A MULTIPLE CASE RUN. A SIMILAR RUN MIGHT BE A MULTIPLE JOB RUN. HERE A CONSIDERATION COULD BE A COMPARISON OF TIMING CONSIDERATIONS. AN EXAMPLE APPEARS BELOW.

```

RUN          *TITLE MODE RUN 1, MINIMUM TIMES
JOB 1        *LOGICAL MODE,01,04.
CASE 1       *SET                                SET DECK
              POW1 = 1.
              POW2 = 1.
              POW3 = 1.
              *END SET
              *BEGIN.
              SW1 = 1 AT 0.                        AN ACTIVE INPUT
              *LIST
CASE 2        *RESET
              *BEGIN.
              SW2 = 1 AT 0.
              *LIST
JOB 2         *TITLE MODE RUN 2, AVERAGE TIMES
              *LOGICAL MODE,02,05.
CASE 1       *SET                                SET DECK
              POW1 = 1.
              POW2 = 1.
              POW3 = 1.
              *END SET
              *BEGIN.
              SW1 = 1 AT 0.
              *LIST
CASE 2        *BEGIN.
              SW2 = 1 AT 0.
              *LIST
JOB 3         *TITLE MODE RUN 3, MAXIMUM TIMES
              *LOGICAL MODE,03,06.
CASE 1        *RESET
              *BEGIN.
              SW1 = 1 AT 0.
              *LIST
CASE 2        *BEGIN.
              *LIST AT 100.
              SW2 = 1 AT 0.
              *LIST
TERMINATION  *$$$$$

NOTE THAT THE SET IS
SUCH THAT IT
CAN CARRY OVER JOBS
WITH GREAT CARE.

GET AN INTERNAL PICTURE
OF THE MODEL WHILE IT
IS RUNNING.

```

MALFUNCTION INPUT IS ILLUSTRATED BY THE FOLLOWING EXAMPLE.

```

*TITLE FAILURE OF RELAY A597-A, AND A598-B
*LOGICAL MODE,02,05.
*SET
POWER = 1.

```

```
ACGEN = 1.  
*END SET  
*BEGIN.  
START = 1 AT 0.  
SW1    = 1 AT 250.  
RA597A, AT 175, P, I.      THIS IS A PERMANENT  
                             FAILURE  
RA598B, AT 175, P, 200..   THIS PERHAPS STICKY  
*LIST                      CONTACTS  
*$$$$$
```

THESE EXAMPLES OBVIOUSLY DO NOT EXHAUST THE FULL RANGE OF INPUT
POSSIBILITIES, BUT THEY DO REPRESENT A GUIDE TO TYPICAL INPUT DATA
DECK SET UP.

TRANSLATION MODE...

AS MODELS HAVE GROWN LARGER AND MORE COMPLEX A FACILITY WAS REQUIRED TO ALLOW FOR BETTER COMMUNICATION AS WELL AS PROVIDE A MEANS FOR FURTHER EDITING, DISPLAY, AND ANALYSIS. THE FOLLOWING DISCUSSION DESCRIBES THE FACILITY ALLOWING THE SIMULATION TO BE OUTPUT IN BINARY FOR IMMEDIATE PRINTING OR FOR LATER PROCESSING.

IN THE TYPICAL INPUT BELOW EACH CARD IS NUMBERED FOR THE EXPLANATION WHICH FOLLOWS...

CARD COLUMNS

CARD 00000000011111111222222222233333333334444444445555555556
NO. 12345678901234567890123456789012345678901234567890

```

1  *      DATA
2  *BINARY OUTPUT    HISTORY
3  *TITLE    THIS IS A SAMPLE RUN
4  *LOGICAL MODE,02,05.
5  *SINGLE SPACE
6  *NAMES                      (NOTE NAMES TAKEN FROM DWS SIMULATION EXAMPLE)
7  ENG      POWER HOUSE ENGINEER
8  MSWT     MAIN POWER SWITCH
9  GEN      POWER GENERATOR
10 PLINE    POWER LINE
11 HLINE    LINE TO HOUSE
12 CSWT     CIRCUIT SWITCH ON WALL
13 PLUG1     ELECTRIC OUTLET 1
14 RADIO     TABLE MODEL RADIO
15 RSWT     RADIO VOLUME SWITCH
16 SOUND     BROADCASTING
17 PLUG2     ELECTRIC OUTLET 2
18 LAMP      FLOOR LAMP (150 WATTS)
19 LSWT      LAMP SWITCH
20 BULB      LIGHT BULB (150 WATTS)
21 LIGHT     LIGHT
22 *END NAMES
23 *BEGIN.
24 ENG = 1 AT 0.      BRING UP POWER.
25 CSWT = 1 AT 50M.   SET ROOM OUTLETS HOT.
26 LSWT = 1 AT 51M.   TURN ON LAMP.
27 RSWT = 1 AT 53M.   TURN ON RADIO.
28 *LIST
29 *END BINARY OUTPUT
30 *SET NAMES
31 *PRINT BINARY      NAMES
32 *$$$$$

```

EXPLANATION...

- CARD 1 IS PRECEDED IMMEDIATELY BY THE BINARY PROGRAM DECK (THE SIMULATION PROGRAM) AND IS FOLLOWED BY CARD 2 WHICH IS THE START OF DATA.
- CARD 2 SIGNALS THAT ALL WHICH FOLLOWS IS TO BE PLACED ON THE BINARY OUTPUT TAPE. THE WORD 'HISTORY' SIGNALS THAT THE HISTORY IS TO BE PRINTED OUT, BUT USING THE SIX CHARACTER VARIABLE NAMES ONLY. ANY DICTIONARY ENCOUNTERED WILL BE PASSED DIRECTLY TO THE BINARY OUTPUT TAPE.
- CARD 3 PUTS A TITLE AT THE TOP OF EVERY PAGE.
- CARD 4 BRINGS IN THE MODEL FOR PROCESSING AND SPECIFIES THE PROPER PICK UP AND DROP OUT TIME TABLES.
- CARD 5 CALLS FOR THE HISTORY TO BE PRINTED WITH SINGLE SPACING.
- CARD 6 SIGNALS THE BEGINNING OF A DICTIONARY WHICH WILL BE PASSED TO THE BINARY OUTPUT TAPE FOR USE AT *PRINT BINARY TIME.
- CARDS 7-21 ARE THE DICTIONARY DATA CARDS AND ARE DERIVED FROM THE DNS SIMULATION EXAMPLE IN THE BEGINNING OF THIS MANUAL.
- CARD 22 SIGNALS THE END OF THE DICTIONARY.
- CARD 23 SIGNALS THE START OF THE CASE.
- CARDS 24-27 ARE THE ACTIVITY INPUTS FOR THE CASE. THEY WOULD CAUSE A HISTORY TO BE PRINTED OUT LIKE THE EXAMPLE EXCEPT INSTEAD OF 4 CASES THERE WOULD BE ONLY ONE.
- CARD 28 WILL CAUSE A PAGE EJECT AND A LIST TO BE PRINTED.
- CARD 29 SIGNALS THAT THE BINARY OUTPUT MODE IS OVER AND THE BINARY OUTPUT TAPE IS PREPARED FOR PRINTING.
- CARD 30 CAUSES THE INITIALIZATION OF MEMORY SO THAT THERE WILL BE ROOM IN MEMORY FOR THE DICTIONARY WHEN IT IS ENCOUNTERED. FOR SMALL MODELS THIS IS PROBABLY NOT NECESSARY (LESS THAN 800 VARIABLES).
- CARD 31 CAUSES THE BINARY OUTPUT TAPE (BOT) TO BE READ IN. IN THIS EXAMPLE THE HISTORY WILL BE REPRINTED BUT BECAUSE THE WORD 'NAMES' IS ON THIS CARD THE VARIABLE NAMES WILL BE REPLACED WITH THEIR SYNONYM EXPRESSIONS.
- CARD 32 END THE COMPUTER RUN.

IF THE BINARY OUTPUT TAPE WERE SAVED IT COULD BE REPRINTED IN A SEPARATE RUN ON ANOTHER DAY BY THE FOLLOWING SEQUENCE

```
*LOGICAL MODE,02,05.  
*SET NAMES  
*PRINT BINARY,... NAMES  
*$$$$$
```

THE PRIMARY ADVANTAGES OF THIS CAPABILITY ARE THE INCREASE IN VARIABLE NAME SIZE, THE ABILITY TO REPRINT, THE INCREASE IN COMMUNICATION VALUE OF THE HISTORY, THE ABILITY TO FURTHER PROCESS A HISTORY IMPLIED BY THE EXISTENCE OF THE BINARY OUTPUT TAPE. IT IS A CAPABILITY MEANT FOR LARGE MODELS WHERE TRANSLATION OF THE VARIABLE NAMES IS DESIRED. OTHER

VARIATIONS ARE AVAILABLE BESIDES THAT GIVEN IN THE EXAMPLE. THEY ARE DISCUSSED IN THE 'ALPHABETICAL LISTING OF CONTROL CARDS, THE SIMULATOR'.

-

PROGRAM SPECIFICATIONS, PREPROCESSOR

1. TITLE..DISCRETE NETWORK SYSTEM PREPROCESSOR PROGRAM
2. ACRONYM.. DNS PREP
3. AUTHOR..C.R. ROZANDAAL AND J.R.LOGAN, GENERAL DYNAMICS CONVAIR
4. DATE..OCTOBER, 1965
5. MACHINE REQUIRED..IBM 7090, 7094, DCS-7044-7094
6. OPERATING SYSTEM..IBSYS
7. MONITER SYSTEM..FORTRAN II VERSION 3
8. LANGUAGE..FAP (FORTRAN ASSEMBLY PROGRAM)
9. MACHINE REQUIREMENTS..4 TAPE UNITS, 1 ON-LINE PRINTER, 2 CHANNELS
10. RESTRICTIONS..
 - A. NUMBER OF VARIABLES, 2600
 - B. VARIABLE NAME SIZE, 1-6 CHARACTERS USING LETTERS A-Z, DIGITS 0-9 IN ANY COMBINATION.
 - C. NAME AND TIME CARD FORMATS ARE FIXED FIELD DATA CARDS.
 - D. EQUATIONS ARE IN A FREE FIELD FORMAT WHICH ARE WRITTEN IN COLUMNS 1-72. COLUMNS 73-80 ARE FOR REFERENCE AND ARE NOT EXAMINED BY THE PROGRAM.
 - E. ALLOTTED MEMORY FOR DATA IS 20-22,000 CELLS DEPENDING ON COMMON DEFINITION.
 - F. ALL REFERENCE TABLES CONSTRUCTED ARE MULTIPLES OF THE NUMBER OF VARIABLES IN THE MODEL.
 - G. PROGRAM TIME BASE IS IN MILLISECONDS.
11. TIMING..THE SMALLER THE MODEL THE SHORTER THE TIME ON THE MACHINE. MINIMUM TIME IS ABOUT 20 SECONDS, TOTAL (INCLUDES PROGRAM LOADING). MAXIMUM TIME (FOR 2600 VARIABLES) WOULD BE 10-12 MINUTES. A NOMINAL CASE OF SAY 1200-1600 VARIABLES WOULD BE 3-5 MINUTES.

INSTALLATION DECK SETUP, THE PREPROCESSOR

TO SUBMIT A COMPUTER RUN TO THE MSFC COMPUTATION LABORATORY
THE FOLLOWING DECK SETUP IS REQUIRED...

CARD COLUMNS

```
000000000111111111122222222223333333333444444444455555555556666666666777777777
12345678901234567890123456789012345678901234567890123456789012345678901234567
```

```
$JOB      NASA-J.R.LOGAN      ,650670,04,12,I2FE      LOGANS BIN
$ATTACH    A6
$AS        SYSLB3,HI
$PAUSE     READY TAPES
$EXECUTE   FORTRAN
@          EOF      (7-8 PUNCHED IN COLUMN 1)
*          NASA-J.R.LOGAN      ,650670,04,12,I2FE      LOGANS BIN
*          XEQ
```

.....BINARY DECK APPEARS HERE.....

* DATA

.....DATA AND DATA CONTROL CARDS APPEAR HERE.....

*\$\$\$\$ (LAST CARD OF THE DATA DECK)

A PROPERLY FILLED OUT OPERATOR INSTRUCTION CARD WITH THE NECESSARY
SAVE AND PRINT LABELS WILL ACCOMPANY THE PROGRAM DECK.

PROGRAM SPECIFICATIONS, SIMULATOR

1. TITLE..DISCRETE NETWORK SYSTEM SIMULATION PROGRAM
2. ACRONYM..DNS
3. AUTHOR..J.R. LOGAN, GENERAL DYNAMICS CONVAIR
4. DATE..OCTOBER, 1965
5. MACHINE REQUIRED..IBM 7090, 7094, DCS-7044-7094
6. OPERATING SYSTEM..IBSYS
7. MONITER SYSTEM..FORTRAN II VERSION 3
8. LANGUAGE..FAP (FORTRAN ASSEMBLY PROGRAM).
9. MACHINE REQUIREMENTS..7 TAPE UNITS, 1 ON-LINE PRINTER, 2 CHANNELS.
10. RESTRICTIONS..
 - A. MODEL CHARACTERISTICS ARE SUBJECT TO PREPROCESSOR LIMITATIONS.
 - B. MEMORY ALLOCATION FOR DATA IS 20-22,000 CELLS DEPENDING ON COMMON DEFINITION.
 - C. VALUE DATA BASE IN BINARY IS FLOATING POINT NUMBERS.
 - D. THE SIMULATION CUMULATIVE CLOCK IS IN MILLISECONDS AND CLOCK NUMBERS ARE SIGNED BINARY INTEGERS. THE LARGEST VALUE THE CLOCK CAN HAVE IS 34,359,738,367 MILLISECONDS OR 397.68 DAYS AND THEREFORE THE SIMULATION HISTORY WILL LAST ONLY FOR THAT MUCH TIME IN MILLISECONDS.
 - E. MODEL SIZE IS COMPUTED AS FOLLOWS.
 - 5 * NO. OF VARIABLES
 - + DIRECT REFERENCE TABLE SIZE
 - + EQUATION TABLE SIZE
 - + 7.
 - F. THE NUMBER OF ACTIONS ALLOWED IS...
(SIZE OF DATA REGION - MODEL SIZE) / 3.
THIS INCLUDES INPUTS, ACTIONS, AND REACTIONS AT ANY GIVEN TIME.
11. TIMING..MINIMUM TIME ON THE COMPUTER IS 16-20 SECONDS. OUTPUT TIMING IS APPROX. 100 PAGES, SINGLE-SPACED, WITH 50 ACTIONS-REACTIONS PER MINUTE. TIME ON THE COMPUTER IS A FUNCTION OF MODEL CONSTRUCTION, SIZE, AND FORCING FUNCTION DEFINITION. A NOMINAL RUN WILL BE 5 MINUTES OR LESS. THE MAXIMUM RUN SO FAR IS 65 MINUTES WITH 2000 INPUTS UNDER *CONTROL TIME CONTROL AND SIMULATING A 2400 VARIABLE MODEL FOR 8 DAYS OF ACTIVITY IN MILLISECONDS.

INSTALLATION DECK SETUP, THE SIMULATOR

TO SUBMIT A SIMULATION RUN TO THE MSFC COMPUTATION LABORATORY
THE FOLLOWING DECK SETUP IS REQUIRED...

CARD COLUMNS

000000000111111111122222222223333333333444444444555555555666666666677777777
1234567890123456789012345678901234567890123456789012345678901234567

\$JOB	NASA-J.R.LOGAN	,650670,05,12,12FE	LOGANS BIN
\$ATTACH	A6		
\$AS	SYSLB3,HI		
\$ATTACH	B3		
\$AS	SYSUT2,HI		
\$ATTACH	A4		
\$AS	SYSUT3,HI		
\$PAUSE	READY TAPES		
\$EXECUTE	FORTRAN		
@	EOF	(7-8 PUNCHED IN COLUMN 1)	
*	NASA-J.R.LOGAN	,650670,05,12,12FE	LOGANS BIN
*	XEQ		

.....BINARY DECK APPEARS HERE.....

* DATA

.....DATA AND CONTROL CARD DATA APPEARS HERE.....

*\$\$\$\$ (LAST CARD OF THE DATA DECK)

A PROPERLY FILLED OUT OPERATOR INSTRUCTION CARD WITH THE NECESSARY
SAVE AND PRINT LABELS WILL ACCOMPANY THE PROGRAM DECK.

SIMULATION PROGRAM INSTRUCTION CARD

7094- INSTRUCTION CARD

PROGRAMMER <i>LOGAN</i>	OPER. CODE <i>7</i>	STACK <i>1</i>
LOCATION <i>LOGAN</i>	JOB <i>500670</i>	
IF EXCEEDS MAX: STR <input type="checkbox"/>	INPUT TAPES	
STZ <input type="checkbox"/> DMP <input type="checkbox"/> RETSYS <input type="checkbox"/>	LOGIC	REEL NO.
		DEN.
		LOGIC
NUMBER OF CASES <i>1</i>		
ESTIMATED TIME		
HOURS <i>1</i> MINUTES <i>30</i>		
MAXIMUM TIME		
HOURS <i>1</i> MINUTES <i>30</i>		
FAST TAPES A B C D		
PROGRAMMER COMMENTS: <i>B6 TO PRINTER</i>		
<input type="checkbox"/> (1) ISSYS <input type="checkbox"/> (2) SPCKO <input type="checkbox"/> (3) OTHER	<input type="checkbox"/> (C) COMPILE OR ASSEMBLE <input type="checkbox"/> (E) EXECUTE <input type="checkbox"/> (P) PUNCH <input type="checkbox"/> BCD BIN	
<input type="checkbox"/> (1) FTRN <input type="checkbox"/> (2) FTRN <input type="checkbox"/> (A) APT <input type="checkbox"/> (P) PERT <input type="checkbox"/> (C) OTHER	<input type="checkbox"/> (1) RAP <input type="checkbox"/> (2) RAP <input type="checkbox"/> (S) SOS	

OVER

<input type="checkbox"/> RWA <input type="checkbox"/> SEE ON-LINE <input type="checkbox"/> SEE TECHNIQUES <input type="checkbox"/> MAX. EXCEEDED <input type="checkbox"/> RETURN TO SYS.					
OPER INIT					
OUTPUT TAPES ONLY					
REEL NO.	LOGIC	DEN.	UNIT	NO. OF CPYS.	SAVE
<i>86</i>	<i>8</i>			<i>1</i>	<i>Print</i>

MSFC - Form 533 (Rev August 1964)

STANDARD PRINTED OUTPUT

INPUT <input type="checkbox"/>	UTILITY TAPE LABEL	DATE CREATED
PRINT <input checked="" type="checkbox"/>	DENSITY HIGH <input checked="" type="checkbox"/> LOW <input type="checkbox"/>	REEL REELS
PUNCH <input type="checkbox"/>	MSFC - Form 341-3 (July 1964)	OF
REEL NUMBER	LOG NO.	UNIT #
	<i>86</i>	
#	PROGRAMMER	FILES
1	<i>LOGAN</i>	<i>1</i>
2		
3		
4		
5		
6		
7		

IF THE "*LIST PUNCH" OR "LISTP AT N" OPTIONS ARE USED, THEN IN ADDITION CHECK " ☒ (P) PUNCH" AND CIRCLE "BCD BIN", AND ADD INTO THE APPROPRIATE "OUTPUT TAPES ONLY" COLUMNS

A5	8	PUNCH
----	---	-------

AND FILL OUT AN ADDITIONAL TAPE LABEL FOR PUNCH OUTPUT

INPUT <input type="checkbox"/>	UTILITY TAPE LABEL	DATE CREATED
PRINT <input type="checkbox"/>	DENSITY HIGH <input checked="" type="checkbox"/> LOW <input type="checkbox"/>	REEL REELS
PUNCH <input type="checkbox"/>	MSFC - Form 341-3 (July 1964)	OF
REEL NUMBER	LOG NO.	UNIT #
	<i>A5</i>	
#	PROGRAMMER	FILES
1	<i>LOGAN</i>	<i>1</i>
2		
3		
4		
5		
6		
7		

GENERAL DYNAMICS CONVAIR

A P P E N D I C E S

ALPHABETICAL LIST OF CONTROL CARDS, THE PREPROCESSOR

THE PREPROCESSOR CONTROL CARDS ARE USED PRIMARILY TO DISTINGUISH THE VARIOUS CLASSES OF DATA. A TYPICAL DATA DECK APPEARS AS BELOW..

```

000000000111111111.....
123456789012345678.....

*TITLE      THIS IS A TITLE PRINTED AT THE TOP OF EVERY PAGE
*           COMMENTS
*
*TIMES
      NAME   AND   TIME   DATA   CARDS
*END TIMES
*
*EQUATIONS
      EQUATION CARDS
*END EQUATIONS
*   IF A DICTIONARY IS DESIRED PUT IN THIS SECTION
*NAMES
      NAMES   DATA   CARDS
*END NAMES
*$$$$$      TERMINATION OF DATA

```

FOR REFERENCE PURPOSES THE VARIOUS CONTROL CARDS ARE LISTED BELOW IN ALPHABETICAL ORDER. CONTROL CARDS ARE DISTINGUISHED BY THE OCCURRENCE OF AN ASTERISK (*) IN COLUMN 1 OF THE CARD. THE CHARACTERS OF THE CONTROL WORDS MUST APPEAR IN THE COLUMNS INDICATED.

CONTROL CARD	USAGE
--------------	-------

```

000000000111111111
123456789012345678

```

*DEBUG	FOR PROGRAMMER USE IN CASE OF SUSPECTED DIFFICULTY WHEN MODIFYING THE PROGRAM. *DEBUG CAUSES CORE DUMPS TO BE TAKEN AT SELECTED POINTS IN THE PROGRAM.
*END EQUATIONS	SIGNALS THE END OF THE EQUATION DATA CARDS. ITS OCCURRENCE CAUSES... <ul style="list-style-type: none"> . THE CONVERTED EQUATION TABLE TO BE OUTPUT ON THE BINARY MODEL TAPE (BMD). . THE INDIRECT AND DIRECT REFERENCE TABLES TO BE CONSTRUCTED. . OUTPUT OF THE INDIRECT REFERENCE TABLE TO BMD. . OUTPUT OF THE DIRECT REFERENCE TABLE TO BMD.

*END NAMES SIGNALS THE END OF THE NAMES DECK, CAUSES AN END OF FILE TO BE WRITTEN ON BMD.

*END TIMES SIGNALS THE END OF THE NAME AND TIMES DATA DECK. ITS OCCURRENCE CAUSES THE NAME TABLE TO BE OUTPUT TO BMD, FOLLOWED BY THE TIME TABLES, ONE FILE AT A TIME.

*EQUATIONS SIGNALS THE START OF THE EQUATION DATA DECK.

*INPUT TAPE SWITCHES THE INPUT READING TO THE SPECIAL INPUT TAPE (SPIN) WHICH CONTAINS EITHER THE INPUTS CREATED BY HAND OR THE BCD RESULTS FROM A PREVIOUS PROGRAM WHICH EDITS MODEL DATA IN SOME FASHION.

*NAMES SIGNALS THE START OF THE DICTIONARY DATA CARDS.

*TIMES SIGNALS THE START OF THE NAME AND TIMES DATA CARDS.

*TITLE THE CONTENTS OF COLUMNS 7-80 WILL BE PRINTED AT THE TOP OF EVERY PAGE. ACCOMPANYING THE TITLE, PAGE NUMBERS WILL ALSO BE PRINTED.

* THIS CARD WILL BE PRINTED WHEREVER THE CARD APPEARS. ITS TEXT IS IN COLUMNS 7-80 AND IT IS USED TO COMMENT THE MODEL. LIBERAL USE OF THESE COMMENT CARDS IS HIGHLY RECOMMENDED TO DOCUMENT MODEL CONSTRUCTION.

*\$\$\$\$\$ THIS CARD IS CALLED A TERMINATION CARD. IT CAUSES THE OUTPUT TAPES AND THE COMPUTER RUN TO BE CLOSED.

ALPHABETICAL LIST OF CONTROL CARDS, THE SIMULATOR

THE CONTROL CARDS WHICH ARE DESCRIBED BELOW ARE INPUT TO THE NETWORK SIMULATION PROGRAM ALONG WITH PERTINANT DATA CARDS. IT SHOULD BE NOTED THAT A GIVEN RUN IS MADE UP OF JOBS AND CASES. A JOB IS COMPOSED OF ALL CARDS BETWEEN ONE JOB TYPE CARD (E.G., *LOGICAL MODE CARD) AND EITHER ANOTHER JOB TYPE CARD OR A TERMINATION CARD. A CASE IS DEFINED FROM A SET OF CONTROL CARDS FOLLOWED BY VARIABLE EVENT DATA CARDS TO THE NEXT CONTROL CARD. IN THE TABLES WHICH FOLLOW THE LETTER IN THE CARD TYPE COLUMNS INDICATES RANGE OF CONTROL.. R = APPLIES TO ENTIRE RUN C = APPLIES TO A CASE
J = APPLIES TO A JOB M = IS A MISCELLANEOUS CARD, APPLIES RIGHT NOW

DOTS INSIDE THE CONTROL CARD DESCRIPTION REPRESENT CHARACTER SPACING. THE * MUST OCCUR IN COLUMN 1 OF THE CONTROL CARD AND ALL TEXT SHOULD BE PUNCHED AS INDICATED. THE DESCRIPTIONS ARE ARRANGED ALPHABETICALLY.

FOOTNOTE...COMMENTS MAY BE WRITTEN ON ANY CONTROL CARD (EXCEPT THE TITLE CARD). THE COMMENT MAY NOT START BEFORE THE END OF THE PARTICULAR CARDS CONTROL FORMAT. IN NO CASE MAY COMMENTS BEGIN PRIOR TO COLUMN 7. IF THERE IS ANY DOUBT PLACE COMMENTS IN COLUMNS 30-80. (COMMENTS ON *LIST OR *LIST....CARDS WILL NOT APPEAR IN THE HISTORY PRINTOUT).

CARD NAME	TYPE	TEXT
*BEGIN,T.	C	SPECIFIES THE START OF A CASE. T IS THE TOTAL NUMBER OF EVENTS TO BE PERMITTED AND IS USED TO LIMIT THE MAXIMUM TIME IN WHICH A CASE IS PERMITTED TO RUN.
*BIAS,N.	C	CAUSES ONLY THE TIME BASE TIME TO BE PRINTED ACCORDING TO THE FOLLOWING CALCULATION $TIME + N = TIME$. N MAY BE ANY SIGNED INTEGER.
*BINARY OUTPUT	HISTORY	R CAUSES AN ADDITIONAL OUTPUT MODE TO TAKE PLACE IN WHICH ALL SUBSEQUENT OUTPUT IS PLACED IN RAW DATA FORM (BINARY) ON THE BINARY OUTPUT TAPE. THIS PROCESS CONTINUES UNTIL AN *END BINARY OUTPUT CONTROL CARD IS ENCOUNTERED. WHEN THIS CARD IS ENCOUNTERED THE BINARY OUTPUT TAPE IS CLOSED AND REWOUND. IF THE WORD 'HISTORY' APPEARS THEN THE NORMAL PRINT OUT WILL CONTINUE. IF THIS OPTION IS EXERCISED NORMALLY IT IS BECAUSE THE BINARY OUTPUT TAPE IS TO BE SAVED FOR PROCESSING BY ANOTHER PROGRAM AT A LATER TIME. THE WORD 'HISTORY' IF IT OCCURS MUST BE IN COLUMNS 19-25.
*CLEAR	M	ALL VALUES IN THE VALUE TABLE ARE SET TO 0. (SEE *SET1).

*CONTROL TIME, NDNHNMNSNL.

- C CAUSES A PROCESSING MODE TO BE ENTERED IN WHICH DATA FROM A CASE IS BROUGHT IN AS A FUNCTION OF THE PERIOD SPECIFIED BY THE QUANTITIES TO THE RIGHT OF THE COMMA. N IS ANY INTEGER.
D STANDS FOR DAY.
H STANDS FOR HOUR.
M STANDS FOR MINUTE.
S STANDS FOR SECOND.
L STANDS FOR MILLISECOND.

EACH N IS ASSOCIATED WITH THE LETTER TO ITS RIGHT. EACH TIME SPECIFICATION MAY BE ORDERED IN ANY FASHION AND BLANKS MAY BE INTERSPERSED TO THE RIGHT OF THE COMMA. ANY OF THE FIELDS MAY BE LEFT OUT.

EXAMPLES FOLLOW..

- | | |
|---------------------------|--|
| *CONTROL TIME, 1D. | PERIOD IS ONE DAY. |
| *CONTROL TIME, 24H. | SAME AS PREVIOUS. |
| *CONTROL TIME, 30M. | PERIOD IS HALF HOUR. |
| *CONTROL TIME, 1D12H. | PERIOD IS DAY AND A HALF. |
| *CONTROL TIME, 4H30M3DS. | |
| *CONTROL TIME, 5L20S5H2D. | PERIOD IS 2 DAYS, 5 HOURS,
20 SECONDS, AND 5 MILLISEC-
ONDS. |

USING THE FIRST EXAMPLE SUPPOSE THE INPUTS TO A CASE COVERED A PERIOD OF 8 DAYS. THEN THE FIRST DAYS INPUTS WOULD BE BROUGHT IN FOR PROCESSING. THE SECOND DAYS INPUTS WOULD BE BROUGHT IN WHEN THE FIRST EVENT WAS SELECTED WHICH EXCEEDED 1 DAY. THE THIRD DAYS INPUTS WOULD BE BROUGHT IN WHEN THE FIRST EVENT WAS SELECTED WHICH EXCEEDED 2 DAYS AND SO ON UNTIL THE CASE IS EXHAUSTED.

- | | |
|-------------------|---|
| *COPY NAMES | M CAUSES THE DICTIONARY FILE TO BE COPIED FROM THE BINARY MODEL TAPE INTO MEMORY OVERLAYING ALL TABLES EXCEPT THE NAME TABLE. |
| *CYCLE LIST | C FORCES A LIST TO BE TAKEN WHENEVER TIME CHANGES. USE OF THE *LIST1 CONTROL CARD IN CONJUNCTION WITH THIS CARD IS RECOMMENDED. |
| *DEBUG | R FOR PROGRAMMER USE ONLY, CAUSES CORE DUMPS TO BE TAKEN AT APPROPRIATE PLACES IN THE PROGRAM. |
| *DELETE REACTIONS | J THIS CARD IS NOT SEEN BY THE SIMULATOR IN ITS NORMAL PROCESSING. ITS PURPOSE IS TO DELETE FROM PRINT OUT ANY REACTIONS ON THE BINARY OUTPUT TAPE UNDER *PRINT BINARY CONTROL. |
| *DOUBLE SPACE | M CAUSES PRINTING OF EVENTS TO BE DOUBLE SPACED. |

*EJECT M CAUSES THE NEXT LINE TO BE PRINTED ON A NEW PAGE, WITH A NORMAL HEADING.

*END BINARY OUTPUT M GENERATES A TERMINATION CARD ON THE BINARY OUTPUT TAPE, CLOSES IT AND REWINDS IT SO AS TO BE READY FOR A *PRINT BINARY CONTROL CARD. IT CLOSES THE *BINARY OUTPUT OPTION. NORMALLY THIS CARD WILL BE FOLLOWED BY A *PRINT BINARY CONTROL CARD (Q.V.). IF TRANSLATION OF VARIABLE NAMES IS DESIRED THE *END BINARY OUTPUT CARD SHOULD BE FOLLOWED BY A *SET NAMES CONTROL CARD (Q.V.) BEFORE THE *PRINT BINARY OPTION IS TAKEN.

*END NAMES J SIGNALS THE END OF THE TRANSLATION MODE DICTIONARY DECK.

*END SET M SIGNALS THE END OF A SET DECK. IT IS REQUIRED IF THE *SET CARD IS USED.

*ID M THIS CARD ENABLES A DISTINCTION TO BE MADE BETWEEN VARIOUS USERS OF DRS. IF COLUMNS 67-72 CONTAIN 6 INTEGERS THEN A DATE WILL BE INSERTED IN THE TITLE LINE. E.G., 082065 FOR AUGUST 20, 1965 WILL BE INSERTED IN THE TITLE LINE NEXT TO THE PAGE NUMBER AS 08/20/65.

*INSET M SAVES THE CURRENT VALUE TABLE, IT CAN BE RESTORED BY USING THE *RESET CONTROL CARD.

*LIST M CAUSES THE PRINTING OF ALL THE VARIABLES IN THE SYSTEM. THE NORMAL OUTPUT FORMAT IS 1) OCTAL INDEX NUMBER, 2) VARIABLE NAME, AND VALUE FOLLOWED BY A PERIOD. SEVERAL OPTIONS ARE GIVEN BELOW....

*LIST PUNCH M IF THE WORD PUNCH APPEARS IN COLUMNS 7-11, THEN IN ADDITION TO THE PRINTED LIST THE LIST IS PUNCHED INTO CARDS, THE INDEX NUMBER IS DELETED BEFORE PUNCHING. PRIMARY USE OF THIS CARD IS TO SAVE A SET OF SYSTEM STATES IN ORDER THAT THE NEXT TIME A RUN IS MADE START UP OF THE MODEL CAN BE MADE FROM THE *LIST PUNCH CONDITION. ANOTHER USE OF THIS FEATURE IS TO ENABLE COMPARISON BETWEEN LISTS BY MECHANICAL METHODS. THE PUNCH SIGNAL IS CLEARED AFTER EVERY LIST. THIS MEANS THAT FOR CONTROL CARDS LIKE *CYCLE LIST ONLY THE FIRST LIST WILL BE PUNCHED.

*LIST.....1 M IF A 1 APPEARS IN COLUMN 17 PRINTING OF THE OCTAL INDEX NUMBER IS SUPPRESSED.

*LIST.....1 M IF A 1 APPEARS IN COLUMN 18 PRINTING OF ALL *NO VARIABLE PRINT VARIABLES IS COMPLETELY SUPPRESSED, OR ONLY THE *VARIABLE PRINT VARIABLES WILL BE LISTED.

*LIST1 C SIGNALS THE PRINTING ONLY OF NON-ZERO VALUE VARIABLES WHENEVER A LIST IS TAKEN IN A CASE.

*NO VARIABLE PRINT J THE VARIABLES LISTED IN COLUMNS 1-6 OF THE DATA CARDS FOLLOWING THIS CARD (TILL THE NEXT * CARD) WILL NOT BE PRINTED IN THE HISTORY PRINT OUT (SEE THE *LIST CARD).

*NO VOID PRINT C SUPPRESSES PRINTING OF VOIDED EVENTS.

*PRINT BINARY NAMES
M CAUSES THE BINARY OUTPUT TAPE TO BE INPUT AND ALL DATA WILL BE CONVERTED FROM ITS BINARY FORM AND PRINTED. IF THE WORD NAMES APPEARS IN COLUMNS 19-23 A FLAG WILL BE SET FOR TRANSLATION MODE. THIS OPTION WILL BE OVERRIDDEN BY THE *TRANSLATION MODE AND THE *NO TRANSLATION MODE CARDS AS THEY APPEAR ON THE TAPE.

*RESET M RESTORES SAVED VALUE TABLE VALUES, THUS RESETTNG THE VALUE TABLE TO A PREVIOUSLY DEFINED CONDITION.

*SELECT...11 C SIGNALS VARIOUS OPTIONS REGARDING THE SELECTION OF THE NEXT EVENT. A 1 IN COLUMN 12 CAUSES THE LAST OCCURRING EVENT AT THE SAME TIME IN THE ACTION TABLE TO BE SELECTED AS THE EVENT TO BE PROCESSED (NORMAL MODE IS TO SELECT THE EARLIEST OCCURRING EVENT). A 1 IN COLUMN 11 CAUSES A 0 VALUE EVENT TO BE TREATED AS A TERMINAL (IT WILL NOT LOOK UP ITS REFERENCES).

*SET M THE VALUE TABLE IS CLEARED TO ZEROS, THEN VALUES SPECIFIED ON THE DATA CARDS FOLLOWING THE *SET CARD ARE PLACED IN THE VALUE TABLE. SETTING STOPS WITH THE ENCOUNTER OF THE *END SET CONTROL CARD, AND THE SET VALUE TABLE IS SAVED, TO BE RESTORED ONLY WHEN THE *RESET CARD IS USED.

*SET NAMES M THIS CARD CAUSES INITIALIZATION TO TAKE PLACE IF THE VARIABLE NAMES ARE TO BE TRANSLATED IN A *PRINT BINARY SEQUENCE. THIS CARD SHOULD BE USED IF THERE IS QUESTION ABOUT MODEL SIZE. IN PARTICULAR IT SHOULD BE USED IF THERE ARE MORE THAN ABOUT 1200 VARIABLES AND THE TRANSLATION NAME IS PROGRAM DEFINED TO BE MORE THAN 24 CHARACTERS IN LENGTH.

*SET TERMINALS J THE VARIABLES LISTED IN COLUMNS 1-6 OF THE CARDS WHICH FOLLOW THIS ONE WILL BE DEFINED AS TERMINALS, THIS MEANS THAT THEY WILL NO LONGER REFERENCE THE EQUATIONS IN WHICH THEY ARE USED OR ACTIVATE OTHER VARIABLES.

*SETUP PRINT J CAUSES INITIALIZATION PERMITTING ALL VARIABLES TO BE PRINTED. THIS SET UP IS CHANGED BY THE *VARIABLE PRINT AND THE *NO VARIABLE PRINT CONTROL CARDS (Q.V.).

*SINGLE SPACE M CAUSES THE EVENT PRINT OUT TO BE SINGLE SPACED.

*SUPPRESS CONTROL CARDS C SUPPRESS THE PRINTING OF ALL CONTROL CARDS FROM THE OCCURRENCE OF THIS CARD TO THE FIRST CONTROL CARD OF THE NEXT CASE. ALL COMMENT CARDS WILL BE PRINTED.

*TERMINAL PRINT C CAUSES VARIABLES DEFINED BY EITHER THE PROGRAM OR THE *SET TERMINALS OPTION TO BE IDENTIFIED AS TERMINALS.

*TITLE R PLACES THE TITLE SPECIFIED IN COLUMNS 7-80 INTO THE TITLE STORAGE, THE TITLE WILL BE PRINTED STARTING ON THE NEXT AND FOLLOWING PAGES.

*TRANSLATION MODE C CAUSES PRINTING OF EVENTS IN THE HISTORY TO BE PRINTED AND REPLACING SIX CHARACTER VARIABLE NAMES WITH DICTIONARY NAMES. ANY LISTS TAKEN WILL PRINT DICTIONARY NAMES.

*VARIABLE PRINT J THE VARIABLES LISTED IN COLUMNS 1-6 OF THE CARDS FOLLOWING THIS CARD (UNTIL THE NEXT * CARD) WILL BE PRINTED IN THE HISTORY PRINT OUT. THE PRINTING OF ALL OTHER VARIABLES WILL BE SUPPRESSED. (ALSO SEE THE *LIST CARD FOR THE EFFECT ON A LIST.)

* M COMMENT CARD, ANYTHING DESIRED MAY BE PLACED IN COLUMNS 7-80. IT WILL BE PRINTED AT THE TIME OF ITS OCCURRENCE EVEN IF THE *SUPPRESS CONTROL CARDS OPTION HAS BEEN GIVEN.

*\$\$\$\$ R SIGNALS THE END OF A RUN. ONLY ONE OF THIS CARD IS REQUIRED AND IF THERE ARE ANY CARDS FOLLOWING THIS ONE THEY WILL BE IGNORED.

GUIDE TO CONTROL CARD USAGE, THE SIMULATOR

BECAUSE OF THE NUMBER OF CONTROL CARDS AVAILABLE TO CONTROL THE PROCESSING OF DATA FOR THE DNS SIMULATION PROGRAM IT WAS FELT THAT THE FOLLOWING LISTS WOULD BE USEFUL. EACH LIST REPRESENTS A GROUPING OF CONTROL CARDS THAT ARE RELATED BY FUNCTION, USE, OR TYPE. SEE THE ALPHABETICAL LIST FOR DETAILS.

1. JOB OR CASE CONTROL

THESE CARDS DEFINE OPERATING MODE, CALL IN TABLES AND TERMINATE A RUN

*LOGICAL MODE (RELATED TO GROUP 8.)
*BEGIN,T,P.
*\$\$\$\$\$

2. VALUE TABLE EFFECTS (SET)

THESE CARDS DIRECT THE PRESETTING OF VALUES OR SAVE AND RESTORE THE VALUE TABLE.

*SET
*END SET
*CLEAR
*RESET
*INSET

3. PARAMETER DEFINING CONTROL

THESE CARDS SIGNAL THE OCCURRENCE OF INFORMATION RELATED TO NAMES VARIABLES. (SEE ALSO GROUPS 2.)

*NAMES
*END NAMES
*SET TERMINALS
*VARIABLE PRINT
*NO VARIABLE PRINT

4. VARIABLE PROCESSING CONTROL

THESE CONTROLS AFFECT THE ACTUAL PROCESSING OF EVENTS IN A HISTORY

*SELECT
*SET TERMINALS
*NO CHECK REACTION
*NO EVENT CHECK

5. LIST OR VALUE TABLE PRINTING

THESE CARDS CAUSE VARIOUS LISTS OF VARIABLE VALUES TO BE PRINTED,

*LIST
*CYCLE LIST

- *LIST1
- *LIST PUNCH

6. FORMS CONTROL

THERE ARE SEVERAL TYPES OF CARDS WHICH AFFECT THE ACTUAL PRINTED OUTPUT.

A. PAGING

- *SINGLE SPACE
- *DOUBLE SPACE
- *NEW PAGE
- *EJECT
- *TITLE

B. PRINTING

- *
- *SUPPRESS CONTROL CARDS
- *NO HISTORY PRINT
- *NO REACTION PRINT
- *NO INPUT PRINT
- *NO VOID PRINT
- *SETUP PRINT

C. VARIABLE PRINTING (SEE ALSO GROUP 7.)

- *SETUP PRINT
- *NO VARIABLE PRINT
- *VARIABLE PRINT
- *NO VOID PRINT
- *TERMINAL PRINT

D. VALUE MODIFYING

- *BIAS,N.

7. TRANSLATION MODE

THESE CARDS RELATE TO A REPLACEMENT OF THE 6-CHARACTER VARIABLE NAMES BY UP TO 24 CHARACTER VARIABLE NAMES. (SEE GROUP 8.)

- *TRANSLATION MODE
- *NO TRANSLATION MODE
- *NAMES
- *END NAMES

8. SIMULATION BINARY OUTPUT AND PASS II PRINTING

AS MODELS HAVE GROWN LARGER AND MORE COMPLEX A FACILITY WAS REQUIRED WHICH WOULD ALLOW FOR BETTER COMMUNICATION (AND THUS REQUIRING TRANSLATION AND EDITING) AS WELL AS PROVIDE A MEANS FOR FURTHER EDITING, DISPLAY AND ANALYSIS. THE FOLLOWING

CARDS ALLOW FOR THE SIMULATION TO BE OUTPUT IN BINARY FOR IMMEDIATE PRINTING OR FOR LATER REPROCESSING. (SEE ALSO GROUPS 7 AND 1.)

- *BINARY OUTPUT
- *COPY NAMES
- *END BINARY OUTPUT
- *SET NAMES
- *PRINT BINARY
- *DELETE REACTIONS

LIST OF DATA FORMATS, THE SIMULATOR

THE CONTROL CARDS PREVIOUSLY DESCRIBED ARE USED TO DETERMINE THE TYPE OF SIMULATION. THE CARDS TO BE DESCRIBED BELOW ARE OF SEVERAL KINDS BUT THEY HAVE THE CHARACTERISTIC THAT THEIR EFFECT IS ON THE HISTORY AND IS IN TIME. THE DICTIONARY DATA CARDS MODIFY VARIABLE NAMES OR AFFECT THEIR VALUES. THE ACTION COMMAND CARDS AFFECT THE VALUE TABLE PRIMARILY, ALTHOUGH THE RANGE OF APPLICATION IS EXPANDING TO INCLUDE CONTROLS WHICH NEED TO BE APPLIED IN TIME. THE VARIABLE EVENT INPUT CARDS OPERATE DIRECTLY ON THE MODEL.

I. VARIABLE EVENT INPUT CARDS

THESE ARE THE CARDS WHICH DRIVE THE MODEL IN TIME. THE TIME SPECIFIED ON THE EARLIEST SELECTED CARD OF A CASE SETS THE CLOCK. THE SIMULATION CLOCK IS THEN MODIFIED AS DEFINED BY EVENT PICK UP AND DROP OUT TIMES AS CALLED FOR BY THE EQUATION DEPENDENCIES.

A. VARIABLE EVENT INPUT CARDS

FORMAT. FREE FIELD, BLANKS MAY BE FREELY INTERSPERSED.

THE GENERAL FORM IS

NAME = VALUE AT TIME.

NAME = A VARIABLE NAME, 1-6 CHARACTERS IN LENGTH USING A-Z, 0-9.

VALUE = 0, 1, 0.0, 1.0, OR ANY NUMBER OF THE FORM M.N

TIME = TIME OF ACTION AND IS OF THE FORM

ND NH NM NS NL, WHERE

N = AN INTEGER SPECIFYING THE NUMBER OF UNITS OF THE TIME SPECIFIED BY THE CHARACTER TO THE RIGHT OF THE INTEGER. THE ALLOWED CHARACTERS AND THEIR MEANINGS ARE

D = DAYS

H = HOURS

M = MINUTES

S = SECONDS

L = MILLISECONDS

THE TIME SPECIFICATION MAY BE ORDERED IN ANY FASHION, ANY OR ALL OF THE UNITS MAY BE LEFT OUT, AND BLANKS MAY BE INTERSPERSED. IF ONLY AN INTEGER IS PRESENT THEN THE TIME IS ASSUMED TO BE IN MILLISECONDS.

EXAMPLES FOLLOW...

A = 1.0 AT 1D.

B = 1.0 AT 24H.

C = 1.0 AT 1D 6H 45M 38 S 572 L.

D = 1 AT 9.

THUS THE FIRST TWO EVENTS ARE EQUIVALENT. EVENT C WILL TAKE PLACE AT THE END OF 1 DAY, 6 HOURS, 45 MINUTES, 38 SECONDS AND 572 MILLISECONDS. D WILL TAKE PLACE AT 9 MILLISECONDS. NOTE...A '.' (PERIOD) MUST APPEAR AT THE END.

USAGE. THESE CARDS ARE THE ACTIVITY INPUTS TO THE SYSTEM BEING SIMULATED. THEY MAY REPRESENT STARTING EVENTS (BUTTON PUSHING), INITIATING EVENTS FROM A PRE-SET SYSTEM, OR MALFUNCTIONS.

B. CHANGE TIME INPUT CARD

FORMAT. FREE FIELD, ALTERNATIVE VERSIONS ARE GIVEN BELOW.
THE GENERAL FORM IS

NAME, AT TIME, X, DELAY.

THE PUNCTUATION MUST APPEAR.

NAME = SAME AS ON EVENT INPUT CARD.

TIME = SAME AS ON EVENT INPUT CARD. THE WORD 'AT' MUST PRECEDE THE TIME.

X = ONE OF P FOR PICKUP TIME (REFERENCES TIME TABLE 1)

OR D FOR DROP OUT TIME (REFERENCES TIME TABLE 2)

DELAY= THE TIME DELAY TO BE INSERTED IN THE SPECIFIED TIME TABLE. ITS FORMAT IS IDENTICAL TO 'TIME' OR MAY BE THE CHARACTER 'I' SPECIFYING INFINITY.

EXAMPLES FOLLOW...

A, AT 45 M 32S, P, 500L.

VARYIT, AT 1H, D, 30M 30S.

B, AT 1H, P, I.

A WILL CHANGE ITS PICK UP TIME TO 500 MILLISECONDS AT 45 MINUTES AND 32 SECONDS, BUT AT 1 HOUR B WILL BE PREVENTED FROM EVER PICKING UP. VARYIT WILL HAVE ITS DROP OUT TIME CHANGED AS SPECIFIED.

THESE CHANGES WILL HOLD FOR THE LIFE OF A CASE, UNLESS SUPERCEDED BY A LATER INPUT IN THE SAME CASE.

USAGE. THESE CARDS CHANGE THE REFERENCED TIME TABLE ENTRIES FOR THE VARIABLE SPECIFIED, FOR THE LIFE OF THE CASE. THIS PROVIDES A MEANS FOR INSERTING TIME DELAYS INTO THE MODEL OR FOR PREVENTING A VARIABLE FROM ACTING AT ALL.

II. VARIABLE PARAMETER DATA CARDS

THESE DATA CARDS ARE ALL DEFINED AFTER SOME CONTROL CARD IS GIVEN.

*NAMES DATA CARD...

FORMAT. COL. 1- 6 SIX CHARACTER CODED MODEL NAME
COL. 13-36 THE CORRESPONDING TRANSLATION MODE NAME

USAGE. THIS CARD IS USED IN CONJUNCTION WITH THE *TRANSLATION

MODE AND ITS OPTIONS.

*VARIABLE PRINT NAME CARDS...

FORMAT. COL. 1- 6 SIX CHARACTER CODED VARIABLE NAME

USAGE. ONLY THE VARIABLES SPECIFIED WILL BE PRINTED OUT IN THE HISTORY.

*NO VARIABLE PRINT NAME CARDS.

FORMAT. COL. 1- 6 SIX CHARACTER CODED VARIABLE NAME

USAGE. THE NAME SPECIFIED WILL BE DELETED IN ACTION PRINT OUTS AND THE CORRESPONDING REACTION WILL BE DELETED ALSO.

SET MODE ACTIVITY CARDS...

FORMAT. VARIABLE = B.
VARIABLE MAY BE 1-6 CHARACTERS INCLUDING A-Z, 0-9.
THE EQUAL SIGN AND PERIOD MUST BE PRESENT.
B IS ONE OF 0 OR 1 IN *LOGICAL MODE,

USAGE. THESE CARDS OCCUR AS A BLOCK, ONE EQUATION PER CARD. THEY ARE USED WITH THE *SET CARD AND SPECIFY THE VALUE TO WHICH THE VARIABLE IS TO BE SET IN THE STATE TABLE.

*SET TERMINALS NAME CARD

FORMAT. COL. 1- 6 SIX CHARACTER CODED VARIABLE NAME.

USAGE. ANY VARIABLE APPEARING IN THIS DECK WILL BE TREATED AS A TERMINAL, THAT IS, THE EQUATIONS IN WHICH IT IS USED WILL NOT BE LOOKED UP DURING THE HISTORY. THESE CARDS WILL REMAIN IN EFFECT THROUGHOUT A JOB.

III. ACTION COMMAND DATA CARDS

THESE CARDS ARE CONVERTED ON INPUT INTO A FORM LIKE THE VARIABLE EVENT INPUT CARDS AND ARE THEREAFTER TREATED LIKE ACTION DATA. DUE TO THEIR NATURE, THEIR TIME IS ADJUSTED TO INSURE THAT ALL ACTIONS TO OCCUR AT THE TIME SPECIFIED ON THESE CARDS WILL HAVE OCCURRED. IT IS RECOMMENDED THEREFORE THAT DECK SET UP FOR A CASE BE AS FOLLOWS..

CONTROL CARDS
ACTION COMMAND CARDS
VARIABLE EVENT INPUT CARDS

LIST AT TIME CARD...

FORMAT. COL. 1-12 *LIST AT
(4 SIX CHARACTER WORDS).
COL. 13-72 ND NH NM NS NL.
THE TIME SPECIFICATION FORMAT IS THE SAME
AS THE VARIABLE EVENT INPUT CARDS (Q.V.).

USAGE. THIS CARD CAUSES THE PRINTING OF A LIST OF ALL VARIABLES,
AND THEIR STATES, AT THE TIME SPECIFIED. AN INTERRUPT
OF THE SIMULATION HISTORY IS EFFECTED AT THE SIMULATION
TIME SPECIFIED. SIMULATION HISTORY CONTINUES
AFTER THE LIST IS COMPLETE.
IN ADDITION TO THE LIST THE CURRENT CONTENTS OF THE
ACTION TABLE ARE PRINTED. THUS A COMPLETE PICTURE OF
THE MODEL IS GIVEN AT AN INSTANT OF DYNAMIC TIME, THE
STATE OF EVERY ELEMENT OF THE MODEL AND THE EVENTS
WAITING TO TAKE PLACE ARE DISPLAYED. THIS FEATURE CAN
BE USED FOR DETAILED ANALYSIS OF MODEL BEHAVIOR OR
TO DETERMINE THE MODEL STATUS SO THAT A LATER RUN CAN
START FROM THE SPECIFIED POINT IN TIME, ELIMINATING
START UP FROM THE BEGINNING.

LIST PUNCH AT TIME CARD...

FORMAT. SAME AS THE LIST AT TIME CARD EXCEPT
COL. 6 P

USAGE. A LIST IS PUNCHED IN THE SAME FORMAT AS A 'SET' MODE
ACTIVITY CARD.
THE LIST IS BOTH PRINTED AND PUNCHED UNDER THIS OPTION.
A COMMON USE FOR THESE CARDS IS TO PRESET A SIMULATION RUN
TO ELIMINATE START UP AT THE BEGINNING. NOTE THAT IF THE
*LIST1 OPTION IS IN EFFECT THEN ONLY VARIABLES WITH A VALUE
OF NON-ZERO WILL BE PRINTED AND PUNCHED.

HALT AT TIME CARD...

FORMAT. COL. 1-6 *HALT
FOR THE REST OF THE FORMAT SEE THE LIST AT TIME CARD.

USAGE. THIS CARD CAUSES THE SIMULATION HISTORY TO TERMINATE
IF THE TIME SPECIFIED IS EXCEEDED IN THE HISTORY. A
STATE LIST OF ALL VARIABLES IS PRINTED BEFORE THE RUN
IS TERMINATED.

TAPE ASSIGNMENTS, THE PREPROCESSOR

TAPE UNIT	TAPE LABEL	TAPE MODE	TAPE DENSITY	NO. OF FILES	MACHINE FUNCTION	TAPE CONTENTS
A2	STDI	MIXED		1	INPUT	PROGRAM AND DATA.
A6	MOD	BINARY	HI	10/11	SAVE	BINARY MODEL TAPE.
A7	SPIN	BCD	HI	1	LOAD/UTILITY	IF LOAD, CONTAINS PREPROCESSOR INPUTS, OTHERWISE UTILITY.
B6	STDI	BCD		1	PRINT	PRINT OUT OF THE INPUTS.

TAPE ASSIGNMENTS, THE DNS SIMULATOR

TAPE UNIT	TAPE LABEL	TAPE MODE	TAPE DENSITY	NO. OF FILES	MACHINE FUNCTION	TAPE CONTENTS
A2	DSA	MIXED		1	INPUT	PROGRAM AND DATA.
A4	BST	BINARY HI		1	UTILITY	SAVE VALUES (SET-RESET).
A5	DPU	BCD		1	PUNCH	PUNCHED LISTS.
A6	BMD	BINARY HI		10/11	LOAD	BINARY MODEL TAPE, 11TH FILE CONTAINS DICTIONARY OR SYNONYM NAMES IF PRESENT.
A7	BOT	BINARY HI		1	SAVE	IF SAVE, BINARY OUTPUT TAPE CONTAINING BINARY FORM OF THE OUTPUT FOR USE WITH OTHER PROGRAMS.
					UTILITY	IF UTILITY, MAY BE USED FOR PRINTING WITH LARGE MODELS.
B3	BME	BINARY HI		1	UTILITY	CONVERTED INPUTS IN BINARY FORM.
B6	DEV	BCD		1	PRINT	PRINT OUT OF INPUTS. HISTORY, AND LISTS.

DESCRIPTION OF SUBROUTINES, THE PREPROCESSOR

NAME FUNCTION

STARTER CALL MAIN PROGRAM (MAIN) AND GET PROGRAM STARTED.

MAIN DRIVER FOR THE PREPROCESSOR. PERFORMS ALL INPUT-OUTPUT THROUGH THE IO UTILITY ROUTINES AND INTERPRETS THE DATA CALLING ALL APPROPRIATE ROUTINES.

DOPUDO PROCESS A NAME AND TIME DATA CARD AND BUILD TIME TABLES.

PROFUN PROCESS AN EQUATION DATA CARD AND BUILD THE EQUATION TABLE.

TAB4 BUILD THE INDIRECT REFERENCE TABLE.

DOTAB5 BUILD THE DIRECT REFERENCE TABLE.

IO INPUT-OUTPUT UTILITY ROUTINES. ALL IO IS ACTUALLY DONE FROM THESE ROUTINES.

ERREM MESSAGE WRITER ROUTINE CONTAINS ALL MESSAGES AND WRITES THEM.

LCSB LINE AND PAGE COUNTING IS DONE FROM THIS ROUTINE, WHEN COUNTS ARE EXCEEDED PAGE EJECTS ARE FORCED AND THE TITLE AND SUBTITLES ARE PRINTED.

UTIL CONTAINS VARIOUS UTILITY ROUTINES, PREDOMINANTLY THOSE RELATED TO DATA MOVEMENT.

RDC DECIMAL TO BINARY CONVERSION.

FB2D BINARY TO DECIMAL CONVERSION ROUTINES.

SDUMP DUMMY ROUTINE FOR CALLING PDUMP.

ETTSP PROCESSES AN ENCOUNTERED END OF TAPE CONDITION ON THE PROGRAMS STANDARD PRINT TAPE.

WERR GENERALIZED WRITE ERROR RECOVERY ROUTINES (TAPE).

RERR GENERALIZED READ ERROR RECOVERY ROUTINE (TAPE).

START DUMMY ROUTINE MAINTAINED FOR COMPATIBILITY PURPOSES.

(PDUMP MSFC COMPUTATION LAB ROUTINE FOR TAKING MEMORY DUMP).

DESCRIPTION OF SUBROUTINES, THE SIMULATOR

NAME FUNCTION

STARTER CALL MAIN PROGRAM (NBS) AND GET PROGRAM STARTED.

NBS DRIVER FOR THE SIMULATOR, PROVIDES A SKELETON FOR THE MAIN ACTION LOOPS OF THE PROGRAM.

REDIN READS AND CONVERTS ALL INPUT, IF ERRORS ARE DETECTED ALL INPUT IS PROCESSED BUT THE RUN IS THEN TERMINATED.

ACTIN BRINGS IN THE CONVERTED INPUT DATA ONE CASE AT A TIME AND PERFORMS NECESSARY INITIALIZATION FOR EACH CASE.

BACTIN BINARY OUTPUT TAPE PRINT SUBROUTINE.

SUBR CONTAINS A NUMBER OF THE WORKING SUBROUTINES FOR THE PROCESSING OF THE EFFECTS OF AN ACTION IN A CASE. THE PRIMARY SUBROUTINES ARE LISTED BELOW...

CHMH CHECK FOR CASE OVERRUN IN NUMBER OF EVENTS.
FMNTIM GET THE NEXT EVENT TO PROCESS.
TESNAM TEST A VARIABLE NAME TO SEE IF IT IS A COMMAND TO PROCESS.
CHACT CHECK AN ACTIVITY BEFORE IT ENTERS PROCESSING.
STVST STORE A VARIABLE VALUE IN THE VALUE TABLE.
SETEF SET UP TO TEST FOR THE EFFECTS OF AN EVENT.
EFFECT DETERMINES WHETHER OR NOT THERE IS A REACTION TO THIS VARIABLE.
CHRA CHECK THE REACTION TO SEE IF IT IS VALID.
SERAT SET A REACTION IN THE REACTION TABLE.
PRKAT PRINT THE REACTION TABLE.
MART MERGE THE ACTION AND REACTION TABLES AND RESET THE ACTION COUNTER.
SETRE SET UP FOR THE NEXT EVENT TO BE PROCESSED.
CLEANC CLEAN UP AFTER CASE END.
ZSTAT SETS THE VALUES OF ALL VARIABLES TO ZERO.
NSTAT SETS THE VALUES OF ALL VARIABLES TO ONE.
DATCK CHECK TO SEE THAT AVAILABLE MEMORY IS LEFT.

EVALU DETERMINE THE NAME AND VALUE OF A SPECIFIED EQUATION AS A RESULT OF EVALUATING IT.

UTIL CONTAINS A VARIETY OF UTILITY ROUTINES FOR USE BY THE MAIN ROUTINES AS LISTED BELOW....

FETIM FETCH THE PICK UP OR DROP OUT TIME FOR A SPECIFIED VARIABLE.
TCP TEST FOR TIME PARAMETER CHANGES.
GETSY FETCH THE NEXT SYMBOL FROM AN EQUATION.
GETNAM FETCH AN EQUATION NAME.
GETVAL FETCH A VARIABLE VALUE.

DYFCH FETCH THE NEXT BCI CHARACTER.
SEFCH INITIALIZE THE DYFCH ROUTINE.
MISCELLANEOUS DATA MOVEMENT ROUTINES

IO CONTAINS ALL DIRECT INPUT-OUTPUT ROUTINES.

OT OUTPUT CONVERSION AND TRANSLATION SUBROUTINES FOR HISTORY AND VALUE
LIST DATA.

LCSB LINE AND PAGE COUNTING IS DONE FROM THIS ROUTINE, IF COUNTS ARE
EXCEEDED PAGE EJECTS ARE GENERATED AND TITLE LINES AND SUBTITLES
ARE PRINTED. ALSO THE ROUTINES TO ADJUST THE SUBTITLES ARE CONTAINED
IN THIS SUBROUTINE.

ERREM THIS ROUTINE CONTAINS ALL MESSAGES AND PRINTS THEM OUT.

CFD2FB CONVERT DECIMAL TO BINARY.

FB2D CONVERT BINARY TO DECIMAL.

FLFX CONVERT FLOATING POINT TO FIXED AND FIXED POINT TO FLOATING.

ETISP-PC THIS ROUTINE HANDLES AN END OF TAPE CONDITION ON BOTH THE
STANDARD PRINT AND PUNCH TAPES.

SDUMP DUMMY ROUTINE FOR TAKING A TEMPORARY MEMORY DUMP THRU PDUMP.

WERR-RERR GENERALIZED READ-WRITE TAPE ERROR RECOVERY ROUTINES.

START DUMMY ROUTINE MAINTAINED FOR COMPATIBILITY PURPOSES.
(PDUMP MSFC COMPUTATION LAB ROUTINE FOR TAKING MEMORY DUMP).

PROGRAM SPECIFICATIONS, DNS DOWN.TRANSLATION AND CALLING PROGRAM

1. TITLE... DNS DOWN TRANSLATION AND CULLING PROGRAM
2. ACRONYM...DT+C
3. AUTHOR...D.R. DIADDIGO
4. DATE..OCTOBER, 1965
5. MACHINE REQUIRED..IBM 7090, 7094, DCS-7044-7094
6. OPERATING SYSTEM..IBSYS
7. MONITER SYSTEM..IBJOB
8. LANGUAGE..MAP (MACRO ASSEMBLY PROGRAM) AND FORTRAN IV
9. MACHINE REQUIREMENTS..4 TAPE UNITS, 1 ON-LINE PRINTER, 2 CHANNELS
10. TIMING...(10 * (NO. OF ACTIVE TIME CARDS) / 50) SECONDS + 25 SECONDS.

INSTALLATION DECK SETUP,
THE DOWN TRANSLATION AND CULLING PROGRAM

TO SUBMIT A COMPUTER RUN TO THE MSFC COMPUTATION LABORATORY
THE FOLLOWING DECK SETUP IS REQUIRED...

CARD COLUMNS

0000000001111111111222222222333333333444444444555555555666666666777777777
1234567890123456789012345678901234567890123456789012345678901234567

\$JOB NASA-J.R.LOGAN ,650670,02,12,14ME LOGANS BIN
\$ATTACH A7
\$AS SYSCHK2,HI
\$PAUSE READY TAPES
\$EXECUTE IBJOB
\$IBJOB GO,DLOGIC,MAP,FILES,NOSOURCE

.....BINARY DECK.....

\$DATA

.....TIME CARD DATA.....

\$

.....EQUATION CARD DATA.....

\$

A PROPERLY FILLED OUT OPERATOR INSTRUCTION CARD WITH THE NECESSARY
SAVE AND PRINT LABELS WILL ACCOMPANY THE PROGRAM DECK.

DTC PROGRAM INSTRUCTION CARD

7094- INSTRUCTION CARD

PROGRAMMER LOGAN	OPER. CODE 11	STACK # 1				
LOCATION LOGAN'S BIN	JOB # 650670					
IF EXCEEDS MAX: STR <input type="checkbox"/>	INPUT TAPES					
STZ <input type="checkbox"/> DMP <input type="checkbox"/> NETSYS <input checked="" type="checkbox"/>	LOGIC	REEL NO. DEN. LOGIC				
		8 B5				
NUMBER OF CASES 1						
ESTIMATED TIME HOURS 4 MINUTES 4						
MAXIMUM TIME HOURS 5 MINUTES 5						
FAST TAPES A B C D						
PROGRAMMER COMMENTS: File Protect A7 AT JOB END						
<input checked="" type="checkbox"/> (1) IBSYS <input type="checkbox"/> (3) SPOOK <input type="checkbox"/> (0) OTHER	<input type="checkbox"/> (C) COMPILE OR ASSEMBLE <input checked="" type="checkbox"/> (E) EXECUTE <input type="checkbox"/> (P) PUNCH <input type="checkbox"/> (S) BCD BIN					
<input checked="" type="checkbox"/> (4) FTRN II <input type="checkbox"/> (2) FTRN II <input type="checkbox"/> (A) APT <input type="checkbox"/> (P) PERT <input type="checkbox"/> (0) OTHER	<input checked="" type="checkbox"/> (M) MAP <input type="checkbox"/> (F) FAP <input type="checkbox"/> (S) SOS					
OVER _____						
<input type="checkbox"/> RWA <input type="checkbox"/> SEE ON-LINE <input type="checkbox"/> SEE TECHNIQUES <input type="checkbox"/> MAX. EXCEEDED <input type="checkbox"/> RETURN TO SYS.						
OPER INIT _____						
OUTPUT TAPES ONLY						
REEL NO.	LOGIC	DEN.	UNIT	NO. OF CPYS.	SAVE	TAPE
	A7	HE			<input checked="" type="checkbox"/>	

MSFC - Form 533 (Rev August 1964)

Operation Code = 11 Production
12 Checkout

Times Utility

SAVE

PROGRAMMER LOGAN-R		SEQ. NO.	
REEL NUMBER	LOG. NO. A7	UNIT NO.	CREATED ON
REEL _____ OF _____ REELS		NO. FILES	DATE CREATED
IDENTIFICATION DT & C BCD TIMES AND EQUATIONS FOR PREPROCESSOR			
BPI 800 <input checked="" type="checkbox"/> 556 <input type="checkbox"/> 200 <input type="checkbox"/> HI <input checked="" type="checkbox"/> LO <input type="checkbox"/>			
MSFC - Form 341-1 (Rev March 1964)			

SAVE

Equations and Times and Names may be printed, punched, or used directly as input to the Pre-processor Program.

If a run is to be used for a check-out only, then put the A7 up in the "WORK" column of the "INPUT TAPE" list and do not include a "SAVE" request.

TAPE ASSIGNMENTS,
DOWN TRANSLATION AND CALLING PROGRAM

TAPE UNIT	TAPE LABEL	TAPE MODE	TAPE DENSITY	NO. OF FILES	MACHINE , FUNCTION	TAPE CONTENTS
A2	SYSIN1	MIXED		1	INPUT	PROGRAM AND DATA.
A7 (SYSCK1)	DNS	BCD	HI	1	SAVE	CONVERTED (CODED) TIMES EQUATIONS, AND DICTIONARY, CAN BE PRINTED OR PUNCHED.
B(1) (B6)	TIMES	BIN	HI	1	UTILITY	STORAGE FOR THE TIMES.
	SYSOU1	BCD		1	PRINT	PRINT OUT OF INPUTS, AND CULLED AND CODED INPUTS.

DNS DOWN TRANSLATION AND CULLING PROGRAM DESCRIPTION

PURPOSE. GIVEN A SET OF VARIABLE TIME CARDS AND EQUATION CARDS DEFINING A MODEL FOR DISCRETE NETWORK SYSTEM SIMULATION

- 1) TRANSLATE THE ORIGINAL VARIABLE NAME OF 1-30 CHARACTERS IN LENGTH (THIS REPRESENTS PROGRAM CAPACITY, THE NORMAL STANDARD IS 1-24 CHARACTERS OR LESS IN LENGTH) TO AN ARBITRARY SIMULATION MODEL NAME OF 3 CHARACTERS IN LENGTH.
- 2) DOWNTRANSLATE THE LOGIC EQUATIONS USING THE NEW ARBITRARY 3 CHARACTER VARIABLE NAMES, AND ELIMINATE INACTIVE VARIABLES FROM THE EQUATION (DEFINED AS INACTIVE OR SIMPLY NOT PRESENT IN THE TIME CARD DECK).
- 3) CREATE A MODEL TAPE IN THE DNS PREPROCESSOR INPUT FORMAT, INCLUDING A REFERENCE DICTIONARY OF ORIGINAL NAMES TO NEW NAMES.

METHOD. THE SEQUENCE OF UTC PROCESSING IS AS FOLLOWS...

A. INPUT TIME CARDS

1. STORE EXTERNAL NAME IN EXTERNAL NAME TABLE AND CODE NAME IN INTERNAL NAME TABLE.
2. PLACE TIMES, CARD IDENTIFICATIONS, AND INTERNAL NAME ON MEDIARY TAPE.

B. EQUATION PROCESSING

1. SET UP NAME OPERATION TABLE SKELETON.
2. CODE OPERATIONS.

C. CULLING PROCESSING

1. CONDENSE THE EQUATION ELIMINATING INACTIVE VARIABLE NAMES, AND CARRY NOT (/) SYMBOLS INTO SUCCEEDING OPERATORS OR NAMES.
2. EVALUATE EXPRESSIONS INSIDE PARENTHESES (), ELIMINATING () WHEN IT BECOMES EMPTY OR WHEN ONLY ONE VARIABLE IS LEFT (CARRY NOTS TO THE ONE VARIABLE).
3. RECONDENSE THE EQUATION ELIMINATING EQUATION ELEMENTS REDUCED TO ZERO BY STEP 2.
4. ELIMINATE REDUNDANT OPERATORS AND RESTORE PARENTHESIS CODES BACK TO ORIGINAL FORM.

D. EQUATION OUTPUT FOR MODEL.

E. CREATE DICTIONARY AND OUTPUT TO MODEL TAPE.

DECK SETUP. THE DECK SETUP GIVEN BELOW WILL BE USEFUL TO PRODUCTION PERSONNEL AS WELL AS PROVIDING CLARIFICATION FOR METHOD.

CARD COLUMNS

000000000111111111122222222223333333333444444444455555555556666666666777
123456789012345678901234567890123456789012345678901234567890123456789012

\$SETUP CK2 DNS,PRINT,SAVE (SAVE THE NEW MODEL TAPE FOR THE PREPROCESSOR)
\$EXECUTE IBJOB (REFERENCE MONITER UNDER IBSYS)
\$IBJOB GO,DLOGIC,MAP,FILES,NOSOURCE (MONITER OPTIONS)

\$IBLDR DCTDNS

(MAIN PROGRAM AND DRIVER TO SUBROUTINE USAGE)

\$DKEND DCTDNS

\$IBLDR TIMCRD

(PROCESS TIME CARDS...

1. READ MODEL TIME CARDS FROM SYSIN1.
2. DELETE INACTIVE VARIABLES AND CREATE TABLES FOR EXTERNAL NAME TO INTERNAL NAME TRANSLATION AND SEARCH.
3. CREATE INTERMEDIATE TIME TAPE.)

\$DKEND TIMCRD

\$IBLDR EQUAX

(READING OF EQUATION CARDS AND INITIAL SETUP...

1. READ EQUATION CARD AND PRINT IT OUT, PLACE ANY COMMENT CARD IMMEDIATELY ON 'DNS' MODEL TAPE.
2. PROCESS THE EQUATION IDENTIFYING EACH OPERATOR AND NAME, AND CREATING A SKELETON TABLE FOR THE EQUATION.
3. CHECK FOR ILLEGAL CHARACTERS, IF FOUND DELETE THE EQUATION.
4. MAINTAIN CARD IDS (COLS. 73-80) FOR CARRY OVER TO CULL AND TRANSLATION PRINT OUT.)

\$DKEND EQUAX

\$IBLDR CULLG

(ELIMINATION OF INACTIVE VARIABLES...

1. ELIMINATE INACTIVE VARIABLES.
2. ELIMINATE REDUNDANT/USELESS PARENTHESES.
3. ELIMINATE USELESS OPERATORS.)

\$DKEND CULLG

\$IBLDR FINPRT

(THIS ROUTINE INCLUDES 'CULPRT' AND 'TRAPRT'.

CULPRT PRINTS OUT THE CULLED ORIGINAL EQUATION.

TRAPRT PRINTS OUT THE TRANSLATED EQUATION ON THE OUTPUT TAPE AND ALSO PUT IT ON THE TAPE INTENDED FOR PREPROCESSOR INPUT.)

\$DKEND FINPRT

\$IBLDR DICTR

(ENTRY DICTR-READ INTERMEDIARY TIMES TAPE. WRITE STANDARD DNS MODEL TAPE WITH TRANSLATED NAMES AND TIMES.
PRINT SYSTEM OUTPUT TAPE WITH TIME CARDS AND THE TRANSLATED NAME, ORIGINAL NAME AND TIMES.

```

        ENTRY DICME-PRODUCE DICTIONARY FILE FOR THE MODEL TAPE.)
$DKEND DICTR

$IBLDR TRANL
        (PRODUCE AN INTERNAL NAME FROM AN EXTERNAL NAME.)
$DKEND TRANL
$IBLDR MDINP
        (READ INPUT FROM SYSTEM INPUT TAPE.)
$DKEND MDINP

$IBLDR TIMPRT
        (PRINT TIME CARD ON SYSTEM OUTPUT.)
$DKEND TIMPRT

$IBLDR EQUIPRT
        (PRINT ON SYSTEM OUTPUT THE PROCESSED EQUATIONS..ORIGINAL, COLLED,
        AND TRANSLATED. )
$DKEND EQUIPRT

$IBLDR MESSAG
        (PRINT MESSAGES FOR TERMINATION OF EACH SECTION.
        PRINT MESSAGES FOR IRRECOVERABLE ERRORS. )
$DKEND MESSAG

$IBLDR TAPES
        (ENTRY TMTAPE-WRITE MEDIARY TIMES TAPE ('TIMES')).
        ENTRY TMTEOF-WRITE EOF AND REWIND TIMES TAPE,
        ENTRY MDOUT -WRITE BCD IMAGES ON STANDARD MODEL TAPE ('DNS').
        ENTRY MDEOF -WRITE EOF ON 'DNS'.
        ENTRY INTIM -READ MEDIARY TIMES TAPE ('TIMES').
        ENTRY TAPEN -OPEN 'TIMES' AND 'DNS' TAPES. )
$DKEND TAPES

$ENTRY  DCTDNS      (TRANSFER OF CONTROL CARD FOR THE LOADER.)
$DATA   (END OF PROGRAM LOAD.)

```

.....TIMES CARD DATA CARDS.....

\$

.....EQUATIONS DATA CARDS.....

\$

TAPES.	SYSIN1	CONTAINS THE ORIGINAL TIME CARDS AND EQUATIONS.
	B(1)	IS A SCRATCH TAPE FOR TEMPORARY STORAGE OF THE TIMES.
		('TIMES')
	SYSCK1	IS A TAPE PRODUCED BY THE PROGRAM INTENDED AS INPUT

TO THE DNS PREPROCESSOR PROGRAM.
('DNS')
SYSOU1 IS THE PRINT TAPE RECORDING ALL INPUT AND TRANSLATION
INFORMATION.

INPUTS. FORMATS OF THE INPUT DATA IS AS FOLLOWS...

1. TIME CARDS

COLS. 1-36 VARIABLE NAME, LEFT-JUSTIFIED TO COLUMN 1,
EMBEDDED BLANKS ARE NOT PERMITTED, AND ONLY
THE CHARACTERS A-Z, DIGITS 0-9, AND THE
APOSTROPHE (') ARE ALLOWED IN A NAME.
COLS. 37-72 TIME FIELDS IN THE PREPROCESSOR FORMAT BUT
WITH TIME FIELD 1 IN 37-42
WITH TIME FIELD 2 IN 43-48
WITH TIME FIELD 3 IN 49-54
WITH TIME FIELD 4 IN 55-60
WITH TIME FIELD 5 IN 61-66
WITH TIME FIEL 6 IN 67-72
COLS. 73-80 CARD IDENTIFICATION. IF COLUMN 73 CONTAINS AN
'I' THE VARIABLE IS CONSIDERED INACTIVE AND IS
IGNORED.

THE ONLY RESTRICTION IS THE NUMBER OF VARIABLES WHICH CAN BE
STORED IN 20,000 WORDS OF ALLOCATED MEMORY. LIMITS ARE DEFINED
AS FOLLOVED...

2 * (NUMBER OF NAMES BETWEEN 1 AND 6 CHARACTERS)
+ 3 * (NUMBER OF NAMES BETWEEN 7 AND 12 CHARACTERS)
+ 4 * (NUMBER OF NAMES BETWEEN 13 AND 18 CHARACTERS)
+ 5 * (NUMBER OF NAMES BETWEEN 19 AND 24 CHARACTERS)
+ 6 * (NUMBER OF NAMES BETWEEN 25 AND 30 CHARACTERS)
+ 7 * (NUMBER OF NAMES BETWEEN 31 AND 36 CHARACTERS)
MUST BE LESS THAN 20,000.

2. EQUATION CARDS

THE EQUATION CARDS ARE IN A FREE-FIELD FORMAT, IN COLUMNS
1-72, WHILE COLS. 73-80 ARE RESERVED FOR IDENTIFICATION.
THERE MAY BE NO MORE THAN ONE EQUATION PER CARD.

3. \$ CARD

THESE CARDS SIGNAL THE END OF THE TIME CARDS AND THE EQUATION
CARDS. THE \$ IS IN COLUMN 1, COLUMNS 2-6 MAY BE BLANK, BUT
THE REST OF THE CARD MAY CONTAIN ANY TEXT.

4. * CARDS

CARDS WITH AN ASTERISK IN COLUMN 1 MAY BE PLACED ANYWHERE IN THE EQUATION DECK AND WILL BE TREATED AS COMMENTS. NO DATA CARD SHOULD CONTAIN AN ASTERISK IN COLUMN 1 AND SUCH CARDS MAY NOT BE PLACED IN THE TIME CARD SECTION.

OUTPUT. THERE ARE TWO CLASSES OF OUTPUT..

1. PRINTED OUTPUT (SYSOU1)-DT+C PROGRAM ACTIVITY

THE TIME CARDS ARE LISTED WITH THE TRANSLATED NAME, THE ORIGINAL NAME, TIME FIELDS, AND ID IN THAT ORDER PER LINE.

EQUATION CARDS ARE PRINTED ON LINES FLAGGED WITH ASTERISKS AS FOLLOWS...

- * ORIGINAL CARD
- ** CULLED ORIGINAL CARDS
- *** CULLED AND TRANSLATED EQUATION
- **** ERROR MESSAGES IF ANY

2. 'DNS' OUTPUT TAPE (FOR PREPROCESSOR INPUT)

THE TAPE IS IN BCD MODE, 14 WORDS/RECORD, AND APPEARS AS FOLLOWS...

CHARACTERS

00000000011111111122222222223
123456789012345678901234567890.....

*TIMES

.....TIME DATA CARDS IN PREPROCESSOR FORMAT.....

*END TIMES

*EQUATIONS

.....EQUATION DATA CARDS.....

*END EQUATIONS

*NAMES

.....DICTIONARY DATA CARDS.....

*END NAMES

*\$\$\$\$

END-OF-FILE MARK ON TAPE

PROGRAM SPECIFICATIONS, PREPROCESSOR EDITOR PROGRAM

1. TITLE..DISCRETE NETWORK SYSTEM PREPROCESSOR EDITOR PROGRAM
2. ACRONYM..PEP
3. AUTHOR..M.A. OPAL AND J. R. LOGAN, GENERAL DYNAMICS CONVAIR
4. DATE..OCTOBER, 1965
5. MACHINE REQUIRED..IBM 7090, 7094, DCS-7044-7094
6. OPERATING SYSTEM..IBSYS
7. MONITER SYSTEM..FORTRAN II VERSION 3
8. LANGUAGE.. FAP (FORTRAN ASSEMBLY PROGRAM)
9. MACHINE REQUIREMENTS..5 TAPE UNITS, 1 ON-LINE PRINTER, 2 CHANNELS
10. IN GENERAL THE PROGRAM IS RESTRICTED BY THE LIMITATIONS OF THE PREPROCESSOR.

INSTALLATION DECK SETUP, THE PREPROCESSOR EDITOR

TO SUBMIT A COMPUTER RUN TO THE MSFC COMPUTATION LABORATORY
THE FOLLOWING DECK SETUP IS REQUIRED...

CARD COLUMNS

```
0000000011111111222222223333333344444444555555556666666677777777
1234567890123456789012345678901234567890123456789012345678901234567
```

```
$JOB      NASA-J.R.LOGAN      ,650670,03,12,I2FE      LOGANS BIN
$ATTACH   A4
$AS       SYSUT3,HI
$ATTACH   A6
$AS       SYSLB3,HI
$PAUSE    READY TAPES
$EXECUTE  FORTRAN
@      EOF      (7-8 PUNCHED IN COLUMN 1)
*      NASA-J.R.LOGAN      ,650670,03,12,I2FE      LOGANS BIN
*      XEQ
```

.....BINARY DECK.....

* DATA

.....DATA CONTROL CARDS.....

*\$\$\$\$ (LAST CARD OF DATA DECK)

A PROPERLY FILLED OUT OPERATOR INSTRUCTION CARD WITH THE NECESSARY
SAVE AND PRINT LABELS WILL ACCOMPANY THE PROGRAM DECK.

PREPROCESSOR EDITOR PROGRAM INSTRUCTION CARDS

7094- INSTRUCTION CARD

PROGRAMMER LOGAN	OPER. CODE 11	STACK # 1				
LOCATION LOGANS BEN	JOB # 650670					
IF EXCEEDS MAX: STR <input type="checkbox"/>	INPUT TAPES					
STZ <input type="checkbox"/> DMP <input type="checkbox"/> NETSYS <input checked="" type="checkbox"/>	LOGIC	REEL NO. DEN. LOGIC				
	AL	xxxv 8				
NUMBER OF CASES 1		8 A4				
ESTIMATED TIME HOURS _____ MINUTES 5						
MAXIMUM TIME HOURS _____ MINUTES 5						
FAST TAPES A B C D						
PROGRAMMER COMMENTS: B6 TO PRINT						
<input checked="" type="checkbox"/> (1)IBSYS <input type="checkbox"/> (3)SPOOK <input type="checkbox"/> (0)OTHER	<input type="checkbox"/> (C)COMPILE <input type="checkbox"/> OF ASSEMBLE <input checked="" type="checkbox"/> (E)EXECUTE <input type="checkbox"/> (P)PUNCH <input type="checkbox"/> BCD BIN					
<input type="checkbox"/> (4)FTRN IX <input checked="" type="checkbox"/> (2)FTRN IX <input type="checkbox"/> (A)APT <input type="checkbox"/> (P)PERT <input type="checkbox"/> (0)OTHER	<input type="checkbox"/> (M)MAP <input checked="" type="checkbox"/> (F)FAP <input type="checkbox"/> (S)SOS					
OVER _____						
<input type="checkbox"/> RWA <input type="checkbox"/> SEE ON-LINE <input type="checkbox"/> SEE TECHNIQUES <input type="checkbox"/> MAX. EXCEEDED <input type="checkbox"/> RETURN TO SYS.						
OPER INIT _____						
OUTPUT TAPES ONLY						
REEL NO.	LOGIC	DEN.	UNIT	NO. OF CPYS.	SAVE	TAPE
	B6	8		1	PRINT	

MSFC - Form 533 (Rev August 1964)

INPUT PRINT <input checked="" type="checkbox"/> PUNCH <input type="checkbox"/>	UTILITY TAPE LABEL	DATE CREATED
	DENSITY HIGH <input checked="" type="checkbox"/> LOW <input type="checkbox"/>	REEL REELS OF
REEL NUMBER	LOG NO. UNIT #	CREATED ON OPERATOR
B6		
#	PROGRAMMER	FILES CYS SEQUENCE #
1	LOGAN	1 1
2		
3		
4		
5		
6		
7		

Standard Print Tape for Preprocessor Editor

TAPE ASSIGNMENTS, THE PREPROCESSOR EDITOR

TAPE UNIT	TAPE LABEL	TAPE MODE	TAPE DENSITY	NO. OF FILES	MACHINE FUNCTION	TAPE CONTENTS
A2	P	MIXED		1	INPUT	PROGRAM AND DATA.
A4	V	BINARY	HI	1	UTILITY	MEDIARY FOR *INDEX FULL, STORAGE FOR THE BINARY VARIABLE-TERMINAL MATRX.
A6	BMD	BINARY	HI	10/11	LOAD	BINARY MODEL TAPE FROM THE PREPROCESSOR PROGRAM.
B6	Q	BCD	HI	1	PRINT	PRINT OUT OF THE REFERENCE TABLES.

DNS PREPROCESSOR EDITOR PROGRAM DESCRIPTION

PURPOSE. THE PREPROCESSOR EDITOR PROGRAM READS THE BINARY MODEL TAPE, OUTPUT FROM THE DNS PREPROCESSOR PROGRAM AND PRINTS OUT SPECIFIED REFERENCE TABLES ON DEMAND FROM CONTROL CARDS. THESE REFERENCE TABLES PROVIDE DESCRIPTIONS OF THE VARIABLE INTERDEPENDENCIES IN A DNS MODEL.

METHOD. THERE ARE THREE OPTIONS AVAILABLE FROM THIS PROGRAM. THE PROGRAM READS IN THE 'NAME', 'EQUATION', 'INDIRECT', AND 'DIRECT' TABLES FROM THE BINARY MODEL TAPE. ALL REFERENCES USE THE 'NAMES' AS SEEN BY THE PREPROCESSOR. NO SYNONYM CAPABILITY IS PRESENT AT THIS TIME.

THREE OUTPUT OPTIONS ARE AVAILABLE, EACH GOVERNED BY A CONTROL CARD...

1) *INDEX

THIS CONTROL CARD PRODUCES TWO REFERENCE LISTS. THE FIRST LIST IS AN ALPHABETICAL LISTING OF ALL VARIABLES, THEIR CORRESPONDING INTERNAL CODE NUMBERS, AND VARIABLE TYPE. THERE ARE FIVE BASIC VARIABLE TYPES...

INITIATOR-DEFINED ONLY ON THE RIGHT HAND SIDE OF AN EQUATION
TRANSACTION-USED ON LEFT AND RIGHT HAND SIDES OF DIFFERENT
EQUATIONS.

TERMINAL-USED ONLY ON THE LEFT HAND SIDE OF AN EQUATION
SELF-REFERENCING TRANSACTION-A VARIABLE USED IN ITS OWN EQUATION
AND USED IN OTHER EQUATIONS ALSO
(E.G., $A = B * / A.$
 $C = D + A.)$

SELF-REFERENCING TERMINAL-A VARIABLE USED IN ITS OWN EQUATION
ONLY

THE SECOND LIST IS CALLED THE VARIABLE REFERENCE TABLE AND IT DISPLAYS THE USE OF EVERY VARIABLE IN EACH FUNCTION. IN THE PRINT OUT EVERY VARIABLE NAME IS FOLLOWED BY A LIST OF THE FUNCTIONS IN WHICH IT OCCURS.

2) *INDEX FULL

THIS CARD CAUSES FOUR REFERENCE TABLES TO BE PRINTED...

ALPHABETICAL LIST OF VARIABLES-AS ABOVE.

VARIABLE-TERMINAL TABLE-THIS TABLE IS PRODUCED BY PRINTING OUT A MATRIX FORMED BY A DETAILED ANALYSIS OF THE VARIABLE INTERDEPENDENCY TREES. THE MATRIX IS BUILT BY TRACING THE

DEPENDENCY OF EACH TERMINAL ON ITS VARIABLES TO THE RELEVANT INITIATORS. EACH VARIABLE NAME IS THEN PRINTED FOLLOWED BY A LIST OF THE TERMINALS TO WHICH IT REFERS.

TERMINAL-VARIABLE TABLE-THE MATRIX IS THEN INVERTED AND EACH TERMINAL NAME IS PRINTED FOLLOWED BY A LIST OF ALL VARIABLES WHICH ARE RELATED TO IT IN ANY WAY.

VARIABLE REFERENCE TABLE-AS IN 1) ABOVE.

3) *INDEX LOGIC

THIS CONTROL CARD CAUSES PRINTING OF THE VARIABLE-TERMINAL TABLE AND THE TERMINAL-VARIABLE ONLY.

INPUT. THERE ARE FIVE CARDS WHICH CAN BE INPUT TO THIS PROGRAM...

1) COMMENT CARD

FORMAT. COL. 1- 6 *

COL. 7-80 TEXT

USAGE. THIS CARD TYPE MAY BE USED TO COMMENT THE RUN.
IT WILL BE REPRODUCED ON OUTPUT.

2) INDEX CARD

FORMAT. COL. 1-12 *INDEX

COL. 13-80 TEXT

USAGE. SEE CARD TYPE 1 UNDER METHOD.

3) INDEX FULL CARD

FORMAT. COL. 1-12 *INDEX FULL

COL. 13-80 TEXT

USAGE. SEE CARD TYPE 2 UNDER METHOD.

4) INDEX LOGIC CARD

FORMAT. COL. 1-12 *INDEX LOGIC

COL. 13-80 TEXT

USAGE. SEE CARD TYPE 3 UNDER METHOD.

5) TERMINATION CARD

FORMAT. COL. 1- 6 *\$\$\$\$\$

COL. 7-80 TEXT

USAGE. TERMINATES THE RUN.

ONLY ONE OF 2), 3), OR 4) SHOULD BE USED. UNDER FORMAT THE WORD TEXT MEANS THAT ANY COMMENT MAY BE WRITTEN.

TAPE USAGE.

TAPE NO.	MODE	DENSITY	FILES	CONTENTS
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A2	MIXED		1	PROGRAM AND DATA
A4	BIN	HI	1	MEDIARY FOR BINARY MATRIX TAPE
A6	BIN	HI	10/11	BINARY MODEL TAPE
B6	BCD	HI	1	PRINT OUT

SYSTEM ACCOUNTING WILL APPEAR ON A3.

TIMING. PROGRAM RUN TIME FOR OPTION 1 IS 1-5 MINUTES DEPENDING ON MODEL SIZE. RUN TIME IS INCREASED APPRECIABLY FOR OPTIONS 2 AND 3. A NOMINAL CASE FOR A STRAIGHTFORWARD MODEL OF SAY 1000 VARIABLES WILL RUN FOR 4-6 MINUTES ON THE INDEX LOGIC OPTION FOR 20-30 TERMINALS. USE OF THIS PROGRAM FOR LARGE MODELS (ABOVE 1500 VARIABLES) SHOULD BE SPARING.